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The Two New Satellites of Jupiter.

By A. C. D. CROMMELIN.

IT has been my privilege to chronicle in these columns two very sensational astronomical discoveries in the last seven years. The first was the minor planet, Eros, which proved to be our closest planetary neighbour; the second was Phœbe, Saturn's ninth satellite, notable for its immense distance from its primary, and still more for its retrograde motion. The zeal and skill of American astronomers has been rewarded with three more discoveries in the satellite world during the last few months, all of which present some points of special interest.

Till 13 years ago it was entirely unsuspected that any further mysteries lay hidden in the Jovian family. The four Galilean satellites had been known for nearly three centuries, and formed a symmetrical system of worlds, comparable with our moon in size, revolving in almost circular orbits near the plane of their primary's equator. The discovery of a fifth member of the family by Prof. Barnard in 1892 excited great interest; this was a very minute world, but resembled the others in the shape and plane of its orbit. Its chief mathematical interest lay in the rapid motion of the perijove produced by its proximity to Jupiter's equatorial protuberance.

It was doubtless the discovery of Phœbe that suggested the search for very distant satellites of Jupiter, which Prof. Perrine undertook last winter with the Crossley reflector, and which proved successful beyond expectation, resulting in the discovery of two more tiny members of the system. It must be confessed that the Lick observers were somewhat tardy in distributing information on the subject to Europe, so that we were for a time in uncertainty as to whether the new worlds were really satellites, and not minor planets, which happened to be hovering in Jupiter's vicinity. However, there is now no doubt at all that VI. is a true satellite, and scarcely any doubt in the case of VII.

Dr. Frank E. Ross has deduced approximate elements of their orbits from the observations extending up to March last. As satellite VI. has been again observed at Mount Hamilton at the end of July I have used the new observations to correct his elements of this satellite, but as no recent observation of VII. has been reported, his elements are given unchanged.

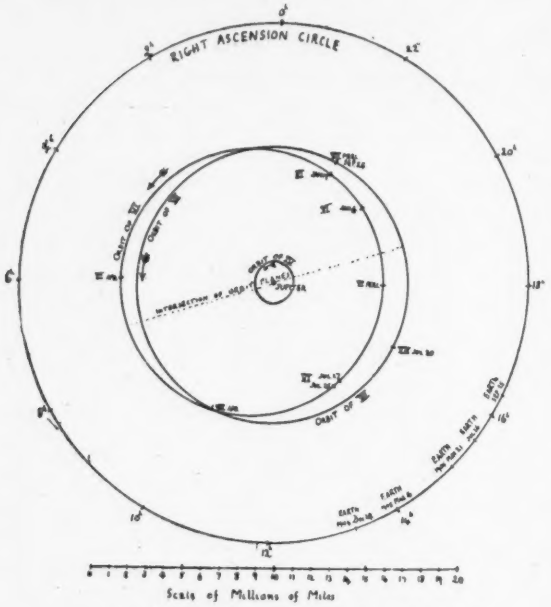
Prof. Perrine had previously announced that the motion of VII. was probably retrograde. Dr. Ross, however, finds that direct motion is much more probable, though the matter is not absolutely certain till the satellite is re-observed or till some images of it are found on Harvard photographs of the neighbourhood of Jupiter taken some years ago. Several of these photographs are available for the search. *

The most extraordinary features of these orbits are their high inclinations to both the equator and orbit of their primary and to each other. The satellites of Mars, Jupiter (5 inner), Saturn (7 inner), and Uranus (probably) move almost exactly in the equatorial plane of their primary, while our moon, Japetus, and Phœbe deviate from this towards the orbit plane of the primary. Neptune's satellite, indeed, appears to be inclined at a considerable angle to both planes, but a repetition of this anomalous feature in the hitherto symmetrical Jovian system was quite unexpected. The near approach to equality in the mean distances is also curious, and the fact that the two orbits interlock, like two links in a chain; in this respect they recall the orbits of Mars and Eros. Their great distance from Jupiter compared with the other satellites is also remarkable, and suggests that they were not original members of the system but have been added later. The capture hypothesis is attractive, but there are grave mathematical difficulties to be overcome before it can be adopted. It would seem that a planet cannot capture a body in such a way as to make it travel in a closed path round itself, but only round some other body, *e.g.*, the various members of Jupiter's comet family have been com-

SATELLITE.	VI.	VII.
Sidereal Period	253d.4	265d.0
Mean distance in miles	7,185,000	7,403,000
Least ,, ,, ...	6,036,000	7,221,000
Greatest ,, ,, ..	8,333,000	7,585,000
Eccentricity	0·16	0·0246
R.A. of Perijove	269°.2	331°.28
R.A. of Pole of Orbit Plane ..	90°	191°.13
Dec.	87°	63°.8
Perijove Passage ..	1904 Dec 15	1905 Jan. 2·25
	1905 Aug. 25	1905 Sept. 24·25
Inclination of Orbit to Jupiter's Equator	28°.4	31°.43
Inclination of Orbit to Jupiter's Orbit	26°.2	32°.0
Inclination of Orbit planes to each other	27°.0	
Maximum Elongation at Opposition	77′	70′
Direction of Orbital Motion	Direct	Direct
Stellar Mag.	14	16
Prob. diameter in miles ..	100	35

*Observations of VII, in August have now been reported. They confirm the direct orbital motion; but appear to show that the orbit is considerably more eccentric, and the period shorter, than the values given by Ross.

pelled by Jupiter to travel in ellipses—not, however, around the planet, but around the sun. Until, therefore, some plausible suggestion has been made of a body that could have captured these satellites, not for itself, but for Jupiter, the capture hypothesis can hardly be regarded as tenable.



Orbits of the three outermost Satellites of Jupiter.

Though the two orbits interlock, yet owing to their large mutual inclinations the satellites cannot approach each other within half a million miles or thereabouts, at which distance such tiny bodies could not perturb each other appreciably. As the nodes and perijoves are moving fairly rapidly, it is possible that after some centuries the orbits may intersect. The prospect of an actual collision is, however, very slender.

Dr. Ross calculates that the node of VII. retrogrades 1°.15 per annum, while the perijove advances 1°.45. He finds the coefficients of the annual equation, evection, variation, and principal solar perturbation in latitude to be 0°.42, 0°.38, 0°.12, and 0°.90 respectively. The corresponding quantities for VI. are considerably larger than these, owing to its greater eccentricity. When these and other perturbations have been accurately determined, the two new satellites will give a determination of the mass of Jupiter, which will be entitled to great weight.

The diagrams of the poles of the orbits, &c., are given as the simplest way of illustrating their situation relatively to the primary's equator, near which the orbits of the five inner satellites lie. Owing to the proximity of the pole of VI. to our North Pole, the satellite is nearly due east or west of Jupiter at elongation. The poles are probably moving round the pole of Jupiter's orbit as in the case of our own moon, but the time of a revolution is probably at least two centuries instead of 18½ years.

It will be seen that the orbits of both VI. and VII. are smaller than that of Phœbe, but their angular distances at elongation are much greater, reaching to 1¼°. Their high inclinations produce most remarkable twists and curves in their apparent motions seen from the earth. A diagram is given showing their apparent places at various dates extending from December 23, 1904, to November 13, 1905. The orbit of VII. is now almost edgewise, and it must have nearly, if not quite, passed across Jupiter's disc on July 18, but so faint an object could not be seen when near its primary.

The direct motion of these satellites is unfavourable to the hypothesis suggested by Prof. W. H. Pickering to account for Phœbe's retrograde motion. According to this the planets originally rotated backwards, and very distant satellites should retain this primitive motion, while solar tides were supposed to have reversed the direction of the planet's rotation before the later satellites were born.

It can scarcely be accidental that retrograde motion exists in the families of the three outer planets, and in these only. It must be confessed, however, that Prof. Pickering's key to the enigma, which seemed so promising at first, can no longer be accepted with great confidence, though it may be possible to modify it so as to cover the new facts.

The numeration of Jupiter's family is now in a state of confusion, the order reckoning outwards from the primary being V., I., II., III., IV., VI., VII.

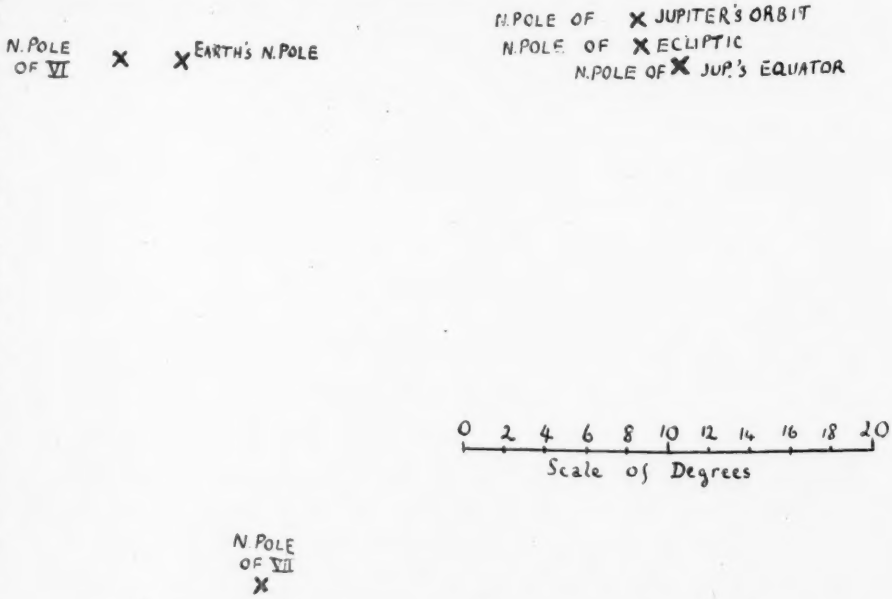
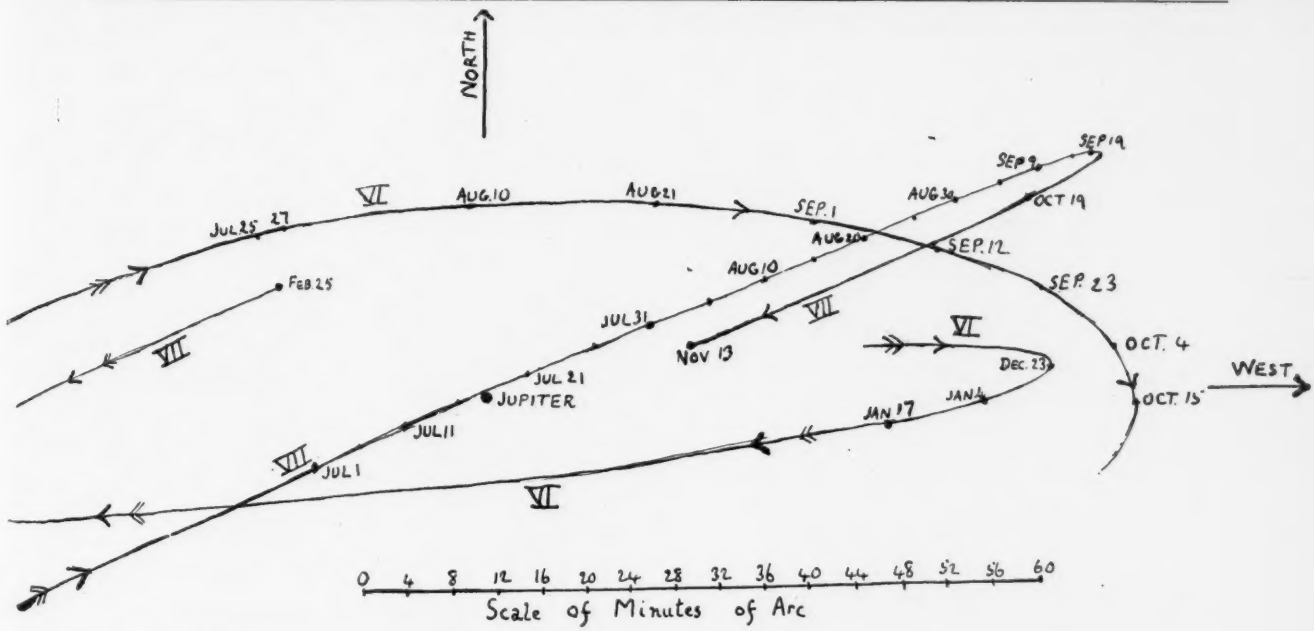

N. POLE OF VI
EARTH'S N. POLE
N. POLE OF JUPITER'S ORBIT
N. POLE OF ECLIPTIC
N. POLE OF JUP.'S EQUATOR
0 2 4 6 8 10 12 14 16 18 20
Scale of Degrees
N. POLE OF VII

Diagram showing the Positions of the Poles of the Orbits of VI. and VII., with reference to Jupiter's Equator and Ecliptic.



Apparent Motion of VI. and VII. in 1904-5.

A similar confusion formerly prevailed in Saturn's system, and was remedied by dropping the numbers and substituting names.

The four Galilean satellites were long ago named Io, Europa, Ganymede, and Callisto. These names, however, are now seldom used. It would seem to be an appropriate time to revive them in lieu of the more prosaic numerals, and to give proper names to the three new satellites.

The tenth satellite of Saturn, recently detected on the Harvard plates, is interesting from its period being 21 days, almost the same as that of Hyperion. This presents another case of linked satellites, but in this case, unlike that of VI. and VII., the planes of motion are probably nearly identical, so that very close approaches are possible; it is rather curious that soon after the discovery of Hyperion its minuteness suggested that it might be one of a ring of satellites analogous to the zone of asteroids, an idea which R. A. Proctor endorsed in his imaginative essay, "A Voyage to the Ringed Planet." This anticipation seems worthy to rank with Swift's and Voltaire's suggestions of two Martian moons as a remarkable astronomical prophecy.

It is satisfactory to learn from a recent Harvard circular that Phœbe has again been photographed during the present apparition of Saturn, the positions agreeing so closely with those predicted from the elements given last year as to remove the smallest doubt as to the substantial accuracy of the adopted orbit.

Dr. F. E. Ross has been engaged on the study of the orbit and perturbations of Phœbe, and I understand that his researches have already been published in the Harvard Annals, but they do not seem to have arrived in England as yet. When they arrive they will be studied with great interest, as likely to throw much light on the perplexing problems which these distant satellites present to us.

Mimicry among Insects.

By PERCY COLLINS.

IT has been said that the strongest testimony to the value of warning coloration is afforded by the likeness which harmless insects sometimes bear to dangerous or noxious ones. Such instances are generally referred to as "mimicry," although the title is also (though somewhat unwisely) employed in descriptions of deceptive appearances which should really be spoken of as protective resemblance. True mimicry, according to the accepted scientific meaning of the term, consists in the external likeness of a poorly-protected creature to a well-protected one, whereby the former is enabled to share in the immunity from attack enjoyed by the latter.

Not infrequently, the young student finds some difficulty in comprehending fully the theory of mimicry, when first the subject is presented to his mind. In such cases a direct appeal to nature is usually more fruitful than abstract explanations. Let us, therefore, take an actual instance of mimicry among British insects.

The poplar clearwing (*Sesia apiformis*), in its general appearance, is exceedingly unlike a typical moth. Its wings are transparent, tinged with yellow; its thorax is brown, with a square patch of bright yellow on each side in front; its abdomen is yellow with a brown belt near the base, and another near the middle; while its legs are deep orange. It has, moreover, a general aspect of trimness and alertness very unusual among the *Lepidoptera*.

But although the poplar clearwing is unlike a moth, it is very much like a hornet. Indeed, it is doubtful whether a person unversed in the study of entomology could distinguish between the two insects merely by ocular examination. Yet a hornet and a moth belong respectively to totally distinct orders of insects; what, therefore, can be the meaning of the close external like-

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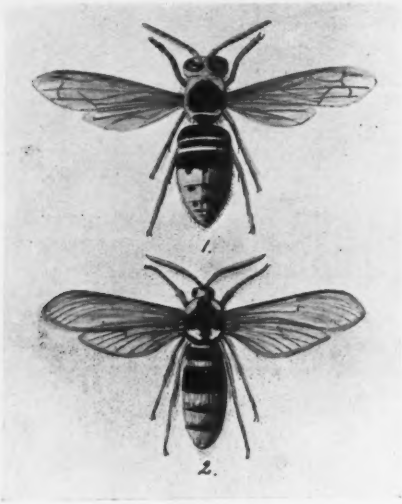
ness which exists between them? Not many years ago, entomologists—while perfectly familiar with the fact of this remarkable resemblance—were quite at a loss to account for it. To-day, in the theory of mimicry, we find a very plausible explanation of the problem.

The hornet is one of those creatures which have been provided by nature with very adequate means of



1. **The Hornet** (*Vespa crabro*).
2. **The Poplar Clearwing** (*Sesia apiformis*).

self defence. It is capable of inflicting painful and even dangerous wounds with its poison-injecting sting; and, as a warning to its would-be assailants, the hornet has been provided (probably through the agency of natural selection) with a distinctive livery of orange and dark brown. In a former article it was shown that such a livery, possessed by a well-protected species, prevents a vast amount of unnecessary mortality because, by its means, insectivorous creatures are able to determine without "experimental tasting" what insects may be eaten with impunity. Bearing this in mind, it is not difficult to realise that a perfectly harmless insect whose colours and form agreed with those of a well-known harmful one, would be likely to share in the immunity enjoyed by its prototype. Granted that the likeness were sufficiently close, insect-eating animals would be completely deceived by it.

In the case of the *Sesia* and the hornet, there is little doubt that this is what actually occurs. The former insect flourishes on the evil reputation possessed by the latter, being mistaken for a stinging insect by the birds, which would be only too glad to eat it did they know it to be a harmless moth. A glance at the accompanying drawing from nature will give the reader an idea of how closely these two insects resemble one another in general appearance. The size and shape of its body and wings, together with the arrangement of its colours, combine to give the moth a hornet-likeness which is truly astonishing when the wide differences of structure and habits existing between the two insects is taken into account.

The order *Hymenoptera* supplies types for mimicry in many parts of the world. Indeed, it may be claimed, in a sense, that the males of the various stinging species are really mimics of the females and workers. For the drones possess no stings, and their "warning liveries" cannot, therefore, have the same direct significance which they possess in the case of the females and workers.

Species of *Hymenoptera* are constantly found to be mimicked by species of *Diptera* in a most perfect manner. Field entomologists in England will be familiar with the bee-flies (*Bombylius*) which, in their hairy covering, general appearance, and the manner in which they hover about a flower, have all the characteristics so familiar in a bee.

Species of *Hemiptera* have been found bearing a striking resemblance to ants, with which insects they company. It cannot, however, be said in what manner —if at all—the bugs are benefited by their likeness to their companions.

Here it may be said that the mere fact of one insect resembling another to a marked extent does not necessarily constitute a case of true mimicry. There is little doubt that a similarity of habitat and environment conduce, at times, to a similarity of form and colouring. Indeed, there are cases on record of insects indigenous to countries extremely remote one from another, which might well be put forward as examples of mimicry were a similarity of form and colouring the only test.

Even in the case of similarly coloured insects living in the same country and under similar conditions, the mere fact of a mutual likeness must not be regarded as proof of a mimetic relationship. The two British beetles *Triplax aenea* and *Tetratoma fungorum*, which belong, the former to the *Clavicornia* and the latter to the *Heteromera*—two widely different families—would be indistinguishable to the novice. Each has a red thorax and bluish black elytra; each, too, may be found on fungoid growth on decaying trees. Yet, so far as the writer is aware, there is nothing known about the life histories of these insects which would justify the assumption that one is a mimic of the other. It is quite conceivable that a similarity of food, surroundings and habit may have brought about this strange likeness in colour and form. To establish a case of true mimicry it is necessary to show that one of the insects concerned—the prototype—possesses some dangerous or noxious quality which renders it dis-

Esthesis ferruginea.

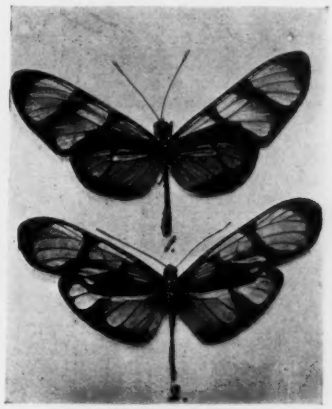
tasteful to the majority of its enemies; and that the mimicking species, by agreeing with the special type of warning coloration concerned, is able to share in the immunity.

This by way of warning to the young observer, whose enthusiasm might lead him to draw conclusions unjustifiable by fact. At the same time, it cannot be doubted that many very perfect instances of true

mimicry exist. Keeping still to the *Hymenoptera*, which on account of their stings constitute such admirable prototypes for mimicry, we find that several European beetles—such as *Emus hirtus* and *Trichius fasciatus*—have a striking bee or wasp likeness, especially when on the wing. The well-known "Wasp" beetles, too, of the genus *Clytus*, are probably to be regarded as instances of mimicry. The most interesting case of a beetle mimicking a large Hymenopterous insect, however, is perhaps that of *Esthesis ferruginea*, a representative of the *Longicornia*, from Australia. This species has the orange and black banding so commonly associated with the possession of a poisonous sting. Moreover, its elytra have become so much shortened as to be quite inconspicuous —a character very rarely seen in the group to which the insect belongs. In this way the wings, whether in use or folded above the abdomen, are fully exposed to view, just as they are in the case of a wasp or a hornet. Of course the beetle has only two flying wings, whereas Hymenopterous insects have four. This, however, is a detail which does not strike the casual observer; moreover, the wings of the beetle are proportionately broad, while there is a lobed portion of the hide margin which has much the appearance of a second pair of wings.

The above is an exceedingly interesting case of true mimicry; yet among the *Lepidoptera* we find numerous instances which are still more striking. No butterfly or moth possesses a sting, but many species are rendered objectionable to insectivorous creatures on account of their noxious juices; and such species are commonly found to be warningly coloured. Thus they constitute prototypes for mimicry. There is, for example, a distasteful butterfly common in the Indian region of the Eastern Hemisphere, known as *Danais melanoides*, the colour pattern of whose wings is mimicked by a number of other butterflies belonging to several distinct families, and by at least one moth. The *Danais* has pale wings, striped and bordered with black; and this design is followed, often with surprising accuracy, by its mimics. A glance at the accompanying photographs, which show *Danais melanoides* and seven of its mimics, will bring this fact home to the reader. Moreover, he will see that the seven butterflies concerned represent no less than five families, viz., *Papilionidæ*, *Nymphalidæ*, *Pieridæ*, *Elymniidæ* and *Satyridæ*.

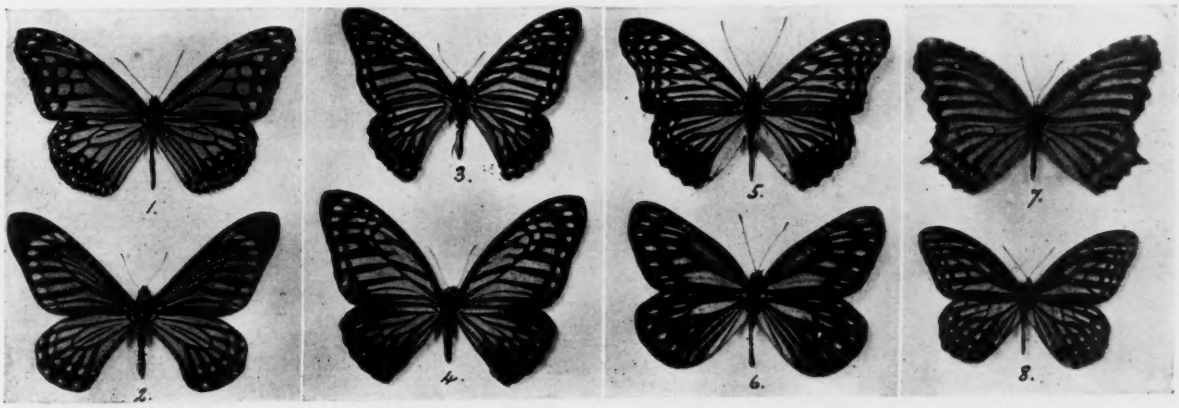
Not infrequently, a mimicking species differs in an extraordinary degree from the typical species of the family to which it belongs. This difference is most striking, perhaps, among some of the South American butterflies—notably the genus *Dismorphia*. This genus belongs to the *Pieridæ*—a family numbering among its members all our well-known "white" butterflies. Its typical South American representatives differ comparatively little from their relatives in other parts of the world. But only an entomologist of experience would recognise *Dismorphia orise* as belonging to the same family. Indeed, it was an actual confusion of such species as this with their prototypes which suggested to the late Henry Walter



1. *Methoma confusa.*
2. *Dismorphia orise.*

Bates the train of thought which led ultimately to his suggesting the theory of mimicry. Among the butterflies which he brought home from South America there were species which, in the hurry of collecting, and packing, he had placed together; but which subsequent examination showed to be widely different in structure.

It may be asked: By what process can this insect (*D. crise*) have come to differ so remarkably from the typical members of its family, as to resemble the distasteful type represented by *Methoma confusa*? At first thought, natural selection, powerful agent though we know it to be, seems incapable of achieving such a result. But we must remember that we are looking at the work—not of tens or hundreds, but possibly of



1. *Danais melanoides.*
2. *Papilio epycides.*
3. *Papilio macareus.*
4. *Papilio xenocles.*
5. *Hestina nama.*
6. *Metaporia agathon*
7. *Elymnias timandra.*
8. *Orinoma damaris.*

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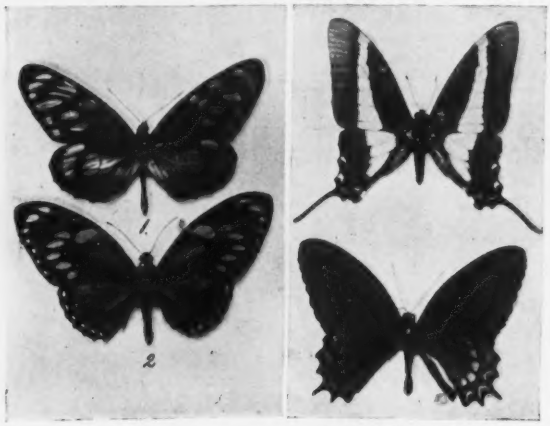
thousands of centuries. In the beginning, it is likely that both the prototype and the mimic were much more simple in colouring and much more like one another than they are at the present time. Then, as the prototype became more specialised, the mimic followed suit, diverging gradually from the typical members of the family to which it belonged, whose development was shaped by other natural influences than affected its own. Thus, through a long succession of changes directed by causes which it is impossible even to guess at, the astonishing difference which we see to-day was established.

This wide difference of a mimic from the typical members of its family is again seen in the case of

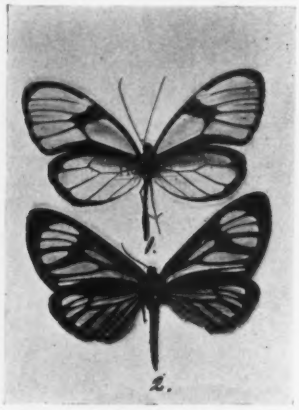


1. *Ituna laniris.*
2. *Papilio ascolias.*

Typical South American *Papilionids.*

Papilio ascolias, from South America, which is a strikingly coloured insect resembling members of the genus *Ituna*. Two typical South American Papilios are also figured ; and by comparing the photograph of *P. ascolias* with these, the reader will be able to realise how widely this insect differs, both in the shape of its wings and in the arrangement of their colours, from the common types of the genus.

Instances of day-flying moths mimicking a well-protected butterfly are not unknown. One of the most striking of these, perhaps, is *Gerra hyelesoides*—a species from Tropical South America—which is a fairly accurate copy of the clear-winged members of the genus *Ithomia*, dominant evil-tasting forms in the district frequented by the moth in question.



1. *Ithomia sp ?*
2. *Gerra hyelesoides.*

The N-Rays of Blondlot.

By J. J. STEWART, M.A., B.Sc. (*Principal of the Technical Institute, Newport*).

II.

VERY curious results were obtained by M. Charpentier, M. Meyer, and others, in their further researches on the characteristics of N-rays. The physiological action in particular was found to be most extraordinary. M. Charpentier found that the N-rays have a noticeable action on the sense of smell. Any source of N-rays, on being brought near to the nose, increases the intensity of an odour as felt by it, and also extends the limit of distance from which it can be recognised.

In the experiments described, various sources of N-rays were made use of, the contracted muscles of the thumb, for instance, and a steel ball in a wooden clamp ; while essence of cassia, and various other essential oils, were employed as effective sources of scent. Similar results were obtained with ether, ammonia, and acetic acid. Not only do the N-rays act directly when brought near the nostrils, but they affect the olfactory sense (according to M. Charpentier) when made to fall upon different portions of the brain, or certain nervous centres connected with the olfactory nerves. A strange thing is that the N-rays also exert an influence on the sources of the scent, a distinct increase of intensity being noticed by the observer when the source of N-rays is brought near a flask containing the odoriferous substance. These substances themselves also emit N-rays.

The brilliance of a phosphorescent screen held in the hand was seen to increase when a source of N-rays was brought up to some other part of the body, especially when it was moved along a nerve. Moreover, the sense of hearing is influenced by the N-rays. When these rays are caused to act upon certain auditory centres, or upon the ear itself, the sense of hearing becomes more acute. A distinct increase of the sound from a watch was observed under the action of the N-radiation.

About the same time that these experiments were carried out, M. E. Meyer noticed that plants emitted N-rays, and these proceeded from all parts of the plant. The same observer, working with M. Charpentier, noticed that stimulation of a nerve or gland increased the emission of N-rays. The emission of the rays from the heart is greater when the vagus nerve is stimulated, and the heart arrested in diastole.

Transmission of these remarkable radiations along a wire from a nerve, or other source, was observed by different experimenters, and the spinal cord was studied by means of N-rays, which were found to be given out more especially from certain portions. M. Charpentier proceeded to some still more striking speculations. He was led to inquire whether there is a specific reinforcement when there is placed near a sensorial organ or the corresponding nervous centres the physical excitant capable of acting upon them. He describes in a communication to the French Academy of Sciences, in May of last year, how he found that when a phosphorescent screen is made having for base an odoriferous substance, the luminosity of this screen is increased opposite the nervous centres, especially near certain of them, which may be called olfactory points. Similar effects occur in the case of the organs of vision, and the related

nervous centres when a screen, with a luminous base, is used. It is inferred from the experiments: (1) That the sensorial nervous centres are specifically different; (2) that there is a certain adaptation, not only between physical agents and the sensorial agents destined to receive them, but between those agents and the nervous centres which perceive them after reception by the sensorial agent; (3) that there are certain common properties implying analogy of nature, between sensorial excitants and the peripheral or central nervous organs destined for their perception, since they show, by the sort of specific resonance referred to, analogous emissive properties.

The existence of N′ rays first noticed by M. Blondlet, and referred to above, seemed to be confirmed by M. Charpentier, who published an account of some observations of his own, which showed that N′ rays exert a physiological action which is the inverse of that of the N-rays. Thus, they cause a decrease of the sense of smell, instead of increasing it, as do the N-rays.

The contributions to the study of the N-rays, and the still more mysterious N′ rays form, indeed, in France, a complete literature by itself. Perhaps nothing quite so extraordinary has previously been made known.

A very noteworthy fact, however, is this, that numerous practised observers, including some of the most eminent scientific men of the day, have been quite unable to observe the effects of these N-rays, even when looking for them under conditions identical with those under which they were recorded by the observers in France.

We have thus next to notice some very important criticisms upon the whole series of published facts, and especially is it necessary to consider the remarks of Dr. Lummer, the German physicist, who commented upon M. Blondlot's researches in a paper read before the German Physical Society in November, 1903.

Dr. Lummer, without wishing, in the meantime, to ous practised observers, including some of the most that a whole series of Blondlot's researches may be almost completely imitated without using any source of radiation, and that the changes in form, brightness, and colour of the surfaces observed by Blondlot may be explained by what goes on in the eye itself, and by the competition between the rods and cones of the retina in vision in the dark. Kries explained the function of the cones as being our apparatus for brightness fit for distinguishing colour, and the rods as blind to colour, and forming our apparatus adapted for darkness. Before the cones perceive coloured light, the rods produce in the brain the impression of colourless brightness. The *fovea centralis* contains cones only, while the rods predominate at the periphery of the retina. Thus, in direct vision (foveal) the rods are excluded, and only come into action in indirect (peripheral) vision. With small brightness these two portions of the visual apparatus come into sharp contest, and if the dimness is great, the colour-blind rods prevail, and everything appears grey. Dr. Lummer, in his work on "The grey glow and the red glow," explains on this theory the sudden changes which occur when a body is observed in a dark room, and its temperature steadily raised. The sudden change from dark to grey, and, again, the sudden increase from the grey glow to the red glow, are due to the successive stimulation, first, of the retinal rods, and then of the retinal cones. Shadowy vision is produced when the *fovea centralis* is not stimulated, and a sheet of heated platinum, for example, observed in the dark. A source of radiation is perceived, but not clearly seen, till the cones also are stimulated, which occurs at about 500° C. In some of Blondlot's experiments the case of the shadowy vision thus described seems to be reproduced, and the effect has been shown to an audience. A dull, glowing platinum plate is first seen by extra foveal parts of the retina. On interposing the hand or a lead screen, the gaze is limited and fixed, the foveal part of the retina is brought to bear, and the action of the rods excluded. The result is that the plate appears less bright and more red-coloured. Time and effort are required for this change, as in the experiments described by Blondlot. The phenomena are thus probably subjective to a large degree, or may be described as due to objective occurrences in the retina.

An extended series of observations were made in the physiological laboratory of the University of Glasgow with the object of confirming Blondlot's observations, but the results were uniformly negative. Prof. McKendrick and Mr. Colquhoun describe their experiments, which were carried out with the help of seven observers who were trained to accurate work. On observing a small fluorescent screen in the dark these observers noticed apparent changes of brightness when there was no contraction of muscle, and no question of N-rays reaching the fluorescent patch. When the observers were asked to look into the distance beyond the bright spot, and report on the brightness of the screens, the result was very noteworthy. They all reported, without exception, that the brightness of the screens was constant, and that muscular contraction made no difference. In this case the accommodation of the eyes for near vision was relaxed. It is suggested that there is a difficulty in accommodating for the fluorescent circle observed, and that there is a wavering movement of the ciliary muscles, and, perhaps, also a wavering in the size of the pupils. Besides this, it should be noticed that Heinrich, some time ago, found that the pupil dilates when examining an object situated in the field of indirect vision, and that it dilates still more during a short mental effort. He found also that, on directing attention to an object in the field of indirect vision, the ciliary muscle relaxes, thus diminishing the curvature of the crystalline lens, and this change is very marked during mental calculation. Prof. McKendrick suggests that the mental condition of some observers in a state of expectancy may react on the intrinsic muscles of their eyes, and thus they may see what they think they should see.

Prof. R. W. Wood, of America, when on a visit to Europe in the autumn of last year, spent some time in examining the methods of obtaining the N-rays in one of the laboratories on the Continent, where the manifestations of the new rays were announced as very distinct. He failed, however, in obtaining any evidence which satisfied him that these rays really existed. After spending some hours in watching and taking part in all the various experiments by which the properties of the N-rays are supposed to be indicated, he left the laboratory with the firm conviction that the few observers who have obtained positive results have been in some way deluded. The interposition of the hand in the path of the rays seemed to make no difference in the brilliance of a small electric spark, which was supposed to be acted upon by these rays, though, according to M. Blondlot, the cutting off from the spark of the N-rays which takes place when the hand is interposed makes a distinct difference in its brightness.

Prof. Wood regards the photographic method of showing an objective effect due to the rays to be quite illusory. The effects of refraction by an aluminium

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prism he found to take place, according to his colleague working with him in a dark room, whether the prism was in position or not. A piece of wood seemed to have the same effect as a file in acting upon the retina to increase its sensitiveness to N-rays; and the removal of wood or file had no influence in stopping the apparent effects which continued to be observed by the experimenter when these exciting objects were removed. On the whole, Prof. Wood, who has himself observed and recorded so many interesting results in his experiments on light, left the laboratory, which was one of the homes of the N-rays, with the firm conviction that all the changes in distinctness of sparks, and variations in luminosity of screens by which the existence of N-rays has been thought to be proved, were purely imaginary.

Other experimenters, both in England and America, as well as in Germany, have severely criticised the methods adopted and the results obtained. No satisfactory reply to these searching criticisms has yet been forthcoming, and it would appear to be highly probable that the long series of researches carried out on these mysterious new rays must be regarded as forming a chapter in the history of human error.

The Cairo Zoological Gardens.

A LARGE number of animals have recently been added to this collection as the result of some members of the staff, including Capt. Stanley Flower, making an expedition to the Sudan. The new additions include three African elephants, 15 Sudanese lions, two addax, one Œlians wart hog, two senegal or saddle-billed storks, and six crocodiles, and amount in all to 129 animals.

Where to be Safe from Earthquakes.

By BERESFORD INGRAM, B.A., F.C.S.

THE terrible effects of the earthquake in Calabria, Italy, last month, together with the equally destructive shocks in India, and the disturbing tremors felt in Yorkshire and Lincolnshire in April last, must have caused more than one person to inquire where he must live to be safest from these calamities, against which the precautions of man are so utterly futile.

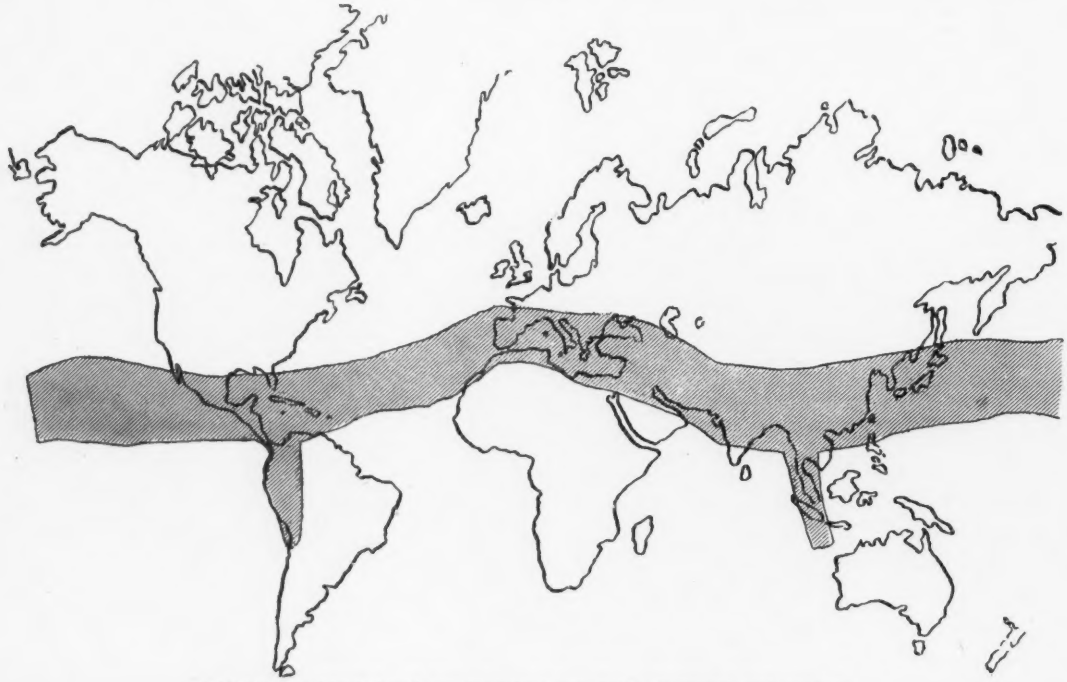
Many years ago Dr. Mallet made an exhaustive investigation of this question, and his work, when properly studied, brought to light a fact of fundamental importance to the English people, *i.e.*, No place in the world can claim an immunity from these terrestrial disturbances, but, nevertheless, *England is less liable to suffer seriously from the effects of a shock than any other European country.*

A review of the following facts, which he, and others, have formulated, will confirm the reader in the acceptance of the above gratifying assurance. Mallet prepared a map of the world, coloured so as to show where earthquake shocks had been experienced. The colour was deepened at those localities which had suffered most or had been subjected to a greater number of upheavals.

When this map was finished and studied, it revealed the following important facts:—

(1.) The bands of the darkest colour run along those mountain chains on which volcanoes occur. This would seem to suggest that volcanic eruptions and earthquake shocks had some connection.

(2.) The above bands (called "seismic bands") generally follow the lines of elevation that mark and



Within the black band earthquakes are both frequent and severe.

divide the great oceanic and terroceanic basins of the earth's surface.

(3.) Earthquakes may become visible at *any* point on the earth's surface, but the greater effects are confined to those areas in the vicinity of the lines of volcanic activity.

Prof. G. Darwin also prepared an "earthquake map," which shows (see Fig.) a broad band completely encircling the world, with which area earthquakes were both frequent and severe.

This band, as will be seen, encloses the following countries:—Southern Europe, the Mediterranean area, Asia Minor, Syria, Persia, Northern India, China, Japan, across the Pacific to Central America and the West Indies, then through the Atlantic to the Azores, Teneriffe, Portugal, Spain, and North-West Africa.

There are other Seismic bands, such as those of the Andes and the Malay Archipelago, but these may be regarded as short offshoots of the "great seismic band;" these latter, it will be noticed, are at right angles to the line of general disturbance.

If we review the list of earthquake shocks that have taken place within recent years, we shall see how they confine themselves to areas that come within the black band marked out on the map.

1868.—Peru and Ecuador. When four cities were destroyed.

1875.—San Jose (Colombia). Earthquake so sudden that the people had no time to escape, so that many thousands of lives were lost.

1903.—Turkestan. Similar disaster to that of San Jose.

1904.—Macedonia.

1905.—Albania.

1905.—Northern India, Lahore. Terrible loss of life.

It is known to everybody, that when a shock occurs in any particular locality, it develops an "earth wave," which traverses a greater or less portion of the globe according to the magnitude of the original disturbance. In fact, it is this wave which, in most cases, produces the terrible effects about which we read.

This wave travels easiest and quickest through solid rock. It has been calculated that it traverses granite at the rate of 1,665 feet per second, which is very much greater than the velocity with which sound travels.

Through shattered rock it goes at the rate of 1,306 feet per second, through slate 1,089 feet per second, and through wet sand with a velocity of 825 feet per second. The deeper the rocks are, the quicker does this wave get through them.

Of course, it travels very much slower through water.

Observations on the velocity of the sea wave, which invariably accompanies the earth wave, show that it depends upon the depth of the water through which it has to pass, going much quicker through deep water than through shallow. When it is remembered that this sea wave is some twenty feet in height, and its velocity may attain six miles a minute, it can be readily imagined that a sea coast with deep water in its immediate vicinity is not a desirable locality during an earthquake.

A very curious anomaly has been observed in the study of this subject, namely, that the region immediately above the centre of the disturbance suffers only very slightly from its effect. The seismological term for this area is the "Epicentrum."

Suppose the centre of the disturbance were twelve miles below the epicentrum (measured perpendicularly), then the region which would be most seriously affected would be twelve miles distant in any direction from the epicentrum on the surface.

Of course, the whole region is affected, but the serious effects are not apparent until a region is approached which is as far away from the epicentrum as the latter is from the internal centre.

It has been estimated that the origin of an earthquake very rarely occurs at a distance of more than 30 geographical miles below the surface, but, as has been stated before, the earth wave has practically no limit.

The surface effects of an earthquake are more destructive when it traverses soft rocks, because the cracks that are produced at the surface are kept open for a longer time, and allow the soil to slip, and the buildings to subside; whilst in the harder rocks, fissures are formed which are narrower, and will close more quickly, causing, thereby, far less displacement.

Perhaps the greatest destruction is caused when the waves travel from compact rocks to loose and soft ones. In these cases complex reflections and reverberations of the shocks ensue, producing the shivering of the surface of the land, which, of all disturbances, is the most to be feared, and the worst to be experienced. This is undoubtedly what has happened in Calabria, where the surface rocks are soft and loose, while the lower ones are hard and compact.

If the angle of emergence of the wave is small, the difficulty which the wave experiences in passing from a compact rock to an overlying soft rock is such that a very small shock is felt. This is of especial importance and interest to England, since our country is so far removed from the areas of intense seismic activity that the angle of emergence is *always* low, added to which the surface of the land is composed mostly of soft rocks; and this is the reason that, when a severe earthquake takes place in Europe or North-West Africa, it is usually felt in Scotland, where the surface is almost uniformly of solid rock; the same shock being scarcely perceptible in England.

Should the reader then live in fear of being swallowed up by the earth, and should he be fortunate enough to be able to choose any part of the world for his abode, he would have to consider (1) his proximity to either active or extinct volcano, (2) his proximity to land bounded by shores with a high gradient, (3) the nature of the strata beneath the surface, and, lastly, the distance from any other earthquake region, having a proper regard as to whether there was a relatively small depth of soft rock on a bed of granite, or other solid substratum.

THE BIRKBECK COLLEGE, Bream's Buildings, Chancery Lane.—This Institution, which has now completed 82 years of educational work, will commence the new session on Monday, October 2nd, when the Right Hon. Sir Edward Fry will give the Opening Address, at 7.30 p.m. The Day and Evening Courses of study comprise the various branches of Natural Science (Chemistry, Physics, Botany, Zoology, Geology, etc.), Mathematics, Latin, Greek, Modern Languages, Economics, Law, Logic, and Commercial Subjects. Courses conducted by recognised teachers of the University provide for the Examinations of the University of London, in the Faculties of Arts, Science, Commerce and Law. The report for the last session shows that during the year 84 students passed some University Examinations, while a large number gained successes at various public examinations. Special classes prepare for the Conjoint Board and Civil Service Examinations.

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The Total Eclipse.

Accounts from all Sources.

IT had been our earnest desire to have given an account, in this number, of the general results obtained by each of the principal parties which left England for the purpose of observing the eclipse. But in some cases the observers prefer not to publish any preliminary account until their full report is presented, while others have been too busy since their return to render any narrative of their doings. The following accounts are, therefore, only a brief summary, which we hope to be able to augment in future issues.

The most westerly expeditions were stationed in LABRADOR, but it seems that clouds completely obstructed the view in these districts. Sir William Macgregor, the Governor of Newfoundland, was at Cartwright, where also was a party from the Lick Observatory. Another party of Canadian observers under Dr. King, was at Hamilton Inlet, and Mr. E. W. Maunder was also there.

At BURGOS, in Spain, the overcast sky greatly impeded the view, but photographs of the corona were secured through rifts in the clouds.

The party at OROPESA, on the East Coast of Spain, which was under Prof. Callendar, of the Royal College of Science, was unfortunately entirely precluded from making any observations on account of the clouds.

Mr. J. Y. Buchanan, F.R.S., however, at Torreblanca, only a few miles further north, had the luck to see the eclipse in a quite clear sky. He describes the corona as being very bright, and with clearly defined edges, like fortifications. The light generally, was so great that he was unable to detect any stars except Venus. The prominences, described as of violet colour, were well seen at the beginning and end, but were not visible at the middle of totality. This should give a practical clue to the height of the prominences.

In the BALEARIC ISLANDS various conditions of weather prevailed. Near Palma, the expedition from the Solar Physics Observatory had taken up a good position. The party, under Sir Norman Lockyer included Dr. J. W. S. Lockyer, Mr. C. P. Butler, Mr. Howard Payn, Mr. F. McClean, and a number of officers and men of H.M.S. "Venus." Though the weather conditions were by no means perfect, since clouds moved perpetually over the sky, yet some fairly good results were obtained with the many instruments provided.

In the centre of the town of Palma, several English astronomers, including Mr. Crommelin, had established themselves on the roof of the Grand Hotel. Here, too, clouds obstructed the view to some extent, although fairly good observations were made throughout the period of totality. But in other directions on the island, the eclipse was absolutely invisible through clouds. Shadow bands were well observed. Within a few miles of the town several observers had a clear sky.

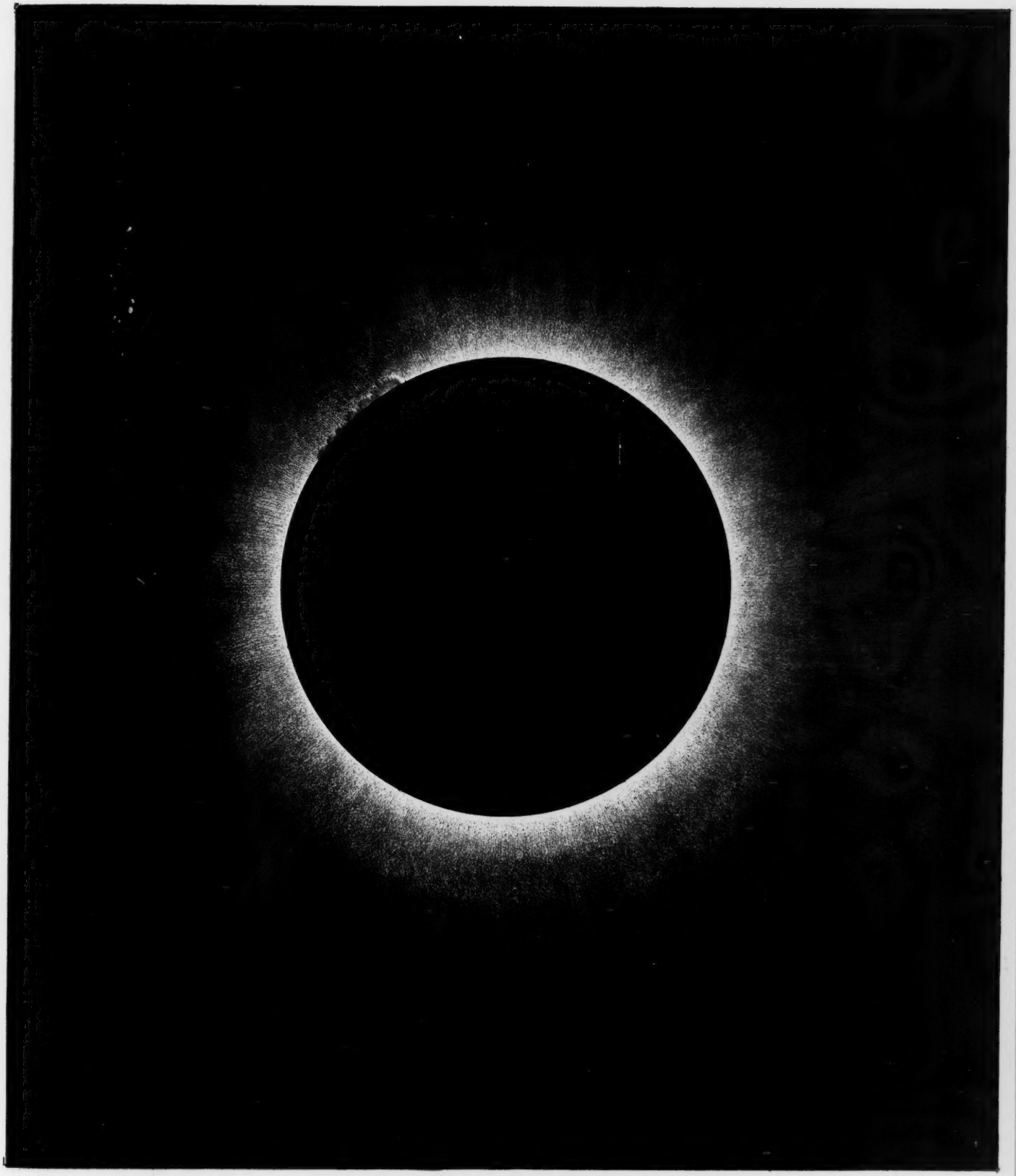
Several British observers, unwilling to experience the mysteries of out-of-the-way Spanish hostelries, and long railway journeys, took the more comfortable, if less business-like, method of going in large steamers. Two liners, timed to be well within the limits of totality at the moment of the eclipse, had arranged to heave-to to enable passengers to have a good view of the phenomenon. In both cases the atmospheric conditions were fairly good, and if no exact or specially valuable observations were made, at all events the observers were well satisfied with what they saw. On board the "Ortona" the prominences were well seen, and described as of "rose-colour" with bases of yellow, and only noted on one side of the sun at a time. The corona, of "a soft pearly blue," had streamers projecting about two diameters, two pairs "above and below" the sun. Venus, Regulus, and Mercury were reported as being visible. The P. and O. steamship "Arcadia" also carried a party provided with small telescopes, two spectroscopes, and many cameras. The vessel hove-to near the Columbretes Rocks, south of Majorca, in perfect calm. Though clouds passed over the sun, there were intervals of perfect clearness. Baily's beads were seen, as were the shadow bands. The conclusions were that the corona was very compact, and very bright, and of a silvery hue. Only one ray stretched out conspicuously from the corona, but four or five minor streamers also existed. The prominences were said to be paler than usual. The thermometer fell from 82.4° to 72.5°.

Perfect weather seems to have prevailed at PHILLIPVILLE, in Algeria, whither our Solar Physics Observatory party was originally destined to go.

At GUELMA also, the conditions were most favourable. Here Mr. Newall made many successful observations with the great spectroscope from Cambridge. M. Trépied, director of the Algiers Observatory, was also installed at this place. The corona was here reported as being very bright, not extensive, and uniformly distributed round the sun. The red protuberances were well seen, as were Baily's beads. Mercury, Venus, and Regulus are reported to have been visible. Thirty-one photographs were taken by the Algiers Mission. The temperature fell during the eclipse from 33° to 28° C. Shadow bands were well observed.

At SFAX, in Tunis, was the party from Greenwich, under the Astronomer Royal, assisted by the crew of H.M.S. "Suffolk." A French party was also here, under M. Bigourdan. Though partially cloudy, the eclipse was fairly well observed and photographed. The corona, as seen here, is reported to have been of the characteristic *maximum* type, with streamers extending to as much as two diameters from the disc, and "of a rosy colour." The following account appeared in the *Times*:—

"The day of eclipse was by much the worst day that was met with. It broke cloudy, cleared a little in the forenoon, but left a nasty haze about the sun that was reinforced as the time approached by light detached clouds blowing from the north-west. The sun was never hidden for more than a few seconds, but it was unpromising for the big telescopes. As the moon crept over the sun's face the temperature, which had been at 90 deg., fell slowly to 84 deg. There was no sense of chill in the air. The party of observers was reinforced by officers and men from the *Suffolk*, told off for watching attendant phenomena, for counting seconds from a metronome, or other help. The light grew weird, and dancing bands of shadow were seen upon the ground and walls. Venus shone out, and soon afterwards Arcturus. Sir William Christie watched the diminishing crescent of the sun's disc on the ground glass of the Thompson camera, and called out "Stand by" 20 seconds before the disc should disappear. All was ready. Then occurred a delay, unaccountable at the moment, but clear enough after-



THE TOTAL ECLIPSE OF 1905.

From a drawing by Major Baden-Powell at Palma.

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wards. There seemed no definite beginning to the eclipse. The crescent never wholly disappeared, or, rather, it merged into a magnificent group of prominences spread over an arc of almost 30 degrees, near the spot where the last of the sun's true disc was seen. They must have been of immense height, and it seemed at least 30 seconds before they were hidden by the advancing moon. At the same time, gradually too, emerged the corona. Observers who have seen many eclipses say it was but a poor corona. To others it did not seem so. In place of the sun's crescent, an inky black disc hung in the sky, with a great span of rosy prominences east of its vertex, and at all other parts of the circumference streaks and streamers of pale but defined substances set with the strangest irr gularity, brilliant round the edge of the disc, and lost to the eye some two diameters distant. Many observers saw a rosy tint in it. Others called it a pure silver or aluminium grey. It was most unmistakably of the type associated with sun spot *maximum*. Many stars were visible, though the sky was never very dark. Too soon its 200 seconds were gone, and with amazing brilliance the sun's disc began to reappear. Nothing remained but to collect results, and to ascertain how much the indefinite beginning had spoilt the plan. It is hoped that it interfered but little. Most observers took successfully as many as seven photographs out of eight. How far the haze and diffused light of the sky may affect these can be answered only when the plates are developed at Greenwich."

In TRIPOLI the eclipse was observed under very favourable circumstances, as described by Prof. Todd in *Nature*. The American expedition from Amherst College set up their instruments at the British Consulate. Observation on the shadow bands were here successfully made. They were "seen as early as ten minutes before totality, and had many remarkable and pronounced peculiarities. They were wavering and narrow, moving swifter than one could walk, at right angles to the wind, their length with it, and waxing and waning five times during the eight minutes preceding totality." A disc eight inches diameter was put up at a distance of 35 feet, in order to observe the outlying streamers of the corona, but nothing was seen protruding beyond the disc. Totality, predicted to last 3m. 9s., was only 3m. 6sec. in duration. "Baily's beads" were well shown in photographs by means of an orthochromatic screen, and other photographs were successfully taken. The corona was "not impressive," being evenly developed, with no long streamers. There were also parties in Tripoli under Prof. Millesovici, of Rome, and M. Liberd, of Paris.

At ASSUAN, up the Nile, were stationed three national expeditions—British, American, and Russian. Prof. Turner, of Oxford, assisted by Mr. Bellamy, made special observations on the light of the corona. The *Times* reports:—"The British party, with invaluable assistance from Captain Lyons and the officers of the Survey Department, obtained five ordinary exposures with an astrographic telescope, besides one with a green colour screen and one enlargement, six photographs polarised by reflection in a horizontal plane, and two in a vertical plane. Mr. Günther, of Magdalen College, Oxford, obtained six plates with a Goerz lens for comparison with similar plates taken in Labrador. Mr. Reynolds's 120-ft. reflector was mounted under unforeseen difficulties, at short notice, with the able assistance of Mr. Keeling." The party from the Lick Observatory, under Mr. Hussy, was equipped with good photographic instruments, some being exactly similar to those used by the other party from the Lick Observatory, who were to observe the eclipse in Labrador. These two stations being situated so far apart that the times of totality differ by two and a half hours, it was hoped that any change in the corona during this period might be detected. Egyptian skies are proverbially clear, but there was a certain amount of haze over the sky, which detracted somewhat from a clear view of the corona. The change of temperature was very slight. The corona appeared small, with its longest streamer to the south-east, about two diameters or less in length, and three shorter ones.

THE SUPPLEMENT.

The coloured plate should convey to those unfamiliar with total eclipses a good idea of the general effect. It can well be supposed that it is impossible to make a really careful drawing during the three brief minutes of totality, and all that is possible is for the artist to make some rough and hurried notes, and after the event is over, to try to depict the same from memory. Under these circumstances, the details portrayed must not be taken as being exact. Photographs alone can give us the true position and dimensions of the prominences. In this case, too, the shape of the corona is not to be taken into account, for two reasons. First, in order to give some idea of the intense brilliancy of the prominences, and of the innermost part of the corona just around the moon's disc, it has been considered necessary to darken the rest of the picture. Secondly, the observations at Palma were marred by thin clouds passing in front of the eclipse, so that the fainter streamers of the corona were not visible, and only an evenly marked band of white light seen around the moon. The prominences, nevertheless, were very clearly seen through a small telescope with an 80-power eyepiece, although it is quite impossible to adequately represent in a drawing the extraordinary luminosity and splendour of these gorgeous flames.

[Just on going to press we have received an interesting account, which must be deferred till next month, from Professor Marcel Moye, of Montpellier University, who saw the eclipse very well from Alcala de Chisvert on the East Coast of Spain.]

TO THE EDITORS OF "KNOWLEDGE."

SIRS,—At Burgos last week several people, shortly after the eclipse, told me that they had seen the fourth of the five splendid prominences visible on the east limb of the sun, together with the Cromosphere between the third and fifth prominences (all counting from the top downwards) of a distinctly green colour, and it would be very interesting to know if others of your readers could confirm this observation of what would seem to have been a coronium prominence; to me they all appeared of the usual cherry-red colour, this fourth one being, perhaps, a little paler than the others.

The Corona was only faint compared to the glorious one we saw at Ovar in 1900.

Yours truly,
C. NIELSEN, F.R.A.S.

Hartlepool, Sept. 9, 1905.

The Harben Lectures.

THIS series of lectures will be delivered at the Royal Institute of Public Health, Russell Square, by Prof. Thomas Oliver, M.A., M.D., LL.D., etc., on October 10, 12, and 17, at 5 p.m. The subject will be "Some of the maladies caused by the air we breathe in the Home, the Factory, and the Mine."

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Seaweeds:

A Holiday Paper for Field Botanists.

By DAVID W. BEVAN, Scarborough F.N. Society.

III.—The Green Seaweeds.

THE Green Seaweeds—last group of all that ends this strange, eventful history—the group that lends brightness and cheerfulness to the rocky pools—are closely allied to the Algæ of the pond and the ditch. In fact, some genera (*Conferva*, *Vaucheria*, and others) have representatives in both waters.

All lovers of fresh-water Algæ know these plants, *Conferva*, with its simple, unbranched row of cells, *Vaucheria*, with its branching filament of one large multi-nucleate cell. The green are the lowliest of the seaweeds. True, some plants of the red and the brown groups are equally simple in build. There is practically no difference, except colour, between the *red* Callithamnion, the *brown* Ectocarpus (a fluffy, yellow, much-branched plant, two inches high or more) and the *green Cladophora* (the common "sea moss"). In each case the filament is a simple row of cells; in each case several cells of the filament bear a branch filament, and this branching is repeated again and again (Fig. 1 shows the three plants in the order

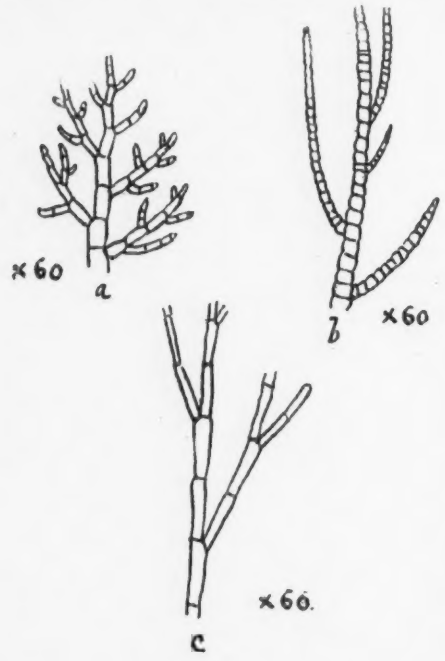

Fig. 1.

named). But the green seaweeds never attain to the complexity of structure which is seen in most of the brown and the red—the Wrack and the *Chilocladia*, to take two plants haphazard. *Ulva*, the Sea Lettuce, the queen of the green seaweeds, is a mere double sheet of cells, every one like its neighbour; *Enteromorpha*, the "sea grass," is the same thing, but is narrow and hollow—hence the name. The two layers of cells are only in contact at the edges, so that the frond is a closed tube. *Ulva* and *Enteromorpha* are shown in Fig. 2.

Moreover, it may be repeated that *the* difference between the three tribes lies in the reproductive process. So that, although the three filamentous plants mentioned above are *built* alike, we find *tetraspores* in Callithamnion, *male and female elements* in Ectocarpus, while the "sea moss" has its own special method of reproduction—a process which, once seen, can never be forgotten. Let us turn, then, to the family arrangements of the green seaweeds.

If the Sea Lettuce is gathered in summer, and a bit cut out with scissors and placed in a drop of sea water under the microscope, the protoplasm in some of the cells is often seen to be divided into, perhaps, a dozen rounded portions (Fig. 3). These are the *Zoospores*.

Fig. 2.

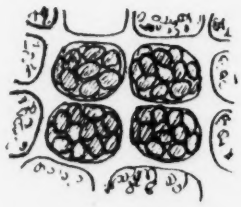

Fig. 3.

They are destined to be discharged, to swim away by a pair of cilia, and to grow at once into new Ulvas. There is no union of male and female. Each spore is fully endowed with the power of germination.

But to see this wonderful sight under the best conditions, *the* plant to study is the common sea moss, *Cladophora rupestris* (not a moss at all), which has comparatively enormous cells. Fresh, young, light green fronds should be selected, and a low power shows that some of the large, oblong cells have their protoplasm split up into many scores of spores. If we are lucky (or, rather, patient), we may see slight restless movements in the mass; after a while they begin to slowly slide about amongst each other, till at last the whole cell becomes a scene of wild and feverish excitement. The spores are all now in motion, hurrying hither and thither, pushing, jostling, in their attempts to find a way out (Fig. 4a). In the end, a tiny, round pore appears at the upper end of the cell (Fig. 4b), and out they all rush one by one into the microscopic ocean, put out their cilia, and start off to see life on their own account. After a while they settle down, draw in their cilia, become round—they were pear-shaped before—and begin the serious business of life; thus bringing to an end one of the most fascinating spectacles that the botanist can ever hope to gaze

upon (see Fig. 4c, which represents a group of zoospores settling on a strand of cotton-wool).

If, now, the basin of sea water, with a supply of Cladophora, is placed aside for an hour or two, a green scum appears on it. This is due to myriads of zoospores, which have come to the top, because they love the light. Pour some of the scum into a potted-meat pot, and place it in the sun. The green all assembles on the sunny side. Cover it over with a

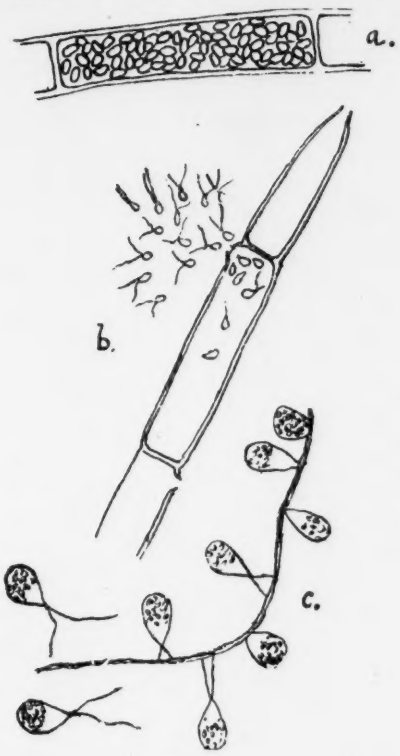

Fig. 4.

paper in which you have cut a stencil of your initials. In a few minutes, the tiny green creatures do you the honour of inscribing those illustrious letters on the watery tablet beneath. Put a drop of the scum under the microscope, and illuminate it from *below*. The zoospores are seen swimming aimlessly about in their thousands. But shut off the light below, and throw a strong light from the *side*. *Instantly* the whole crowd of zoospores turn with their pointed anterior ends to the light, and there ensues a stampede in that direction. Now examine the edge of the drop, to see what is going on at that goal to which this crowd of beings is hastening. A struggle to the death is going on. Hundreds of spores are fighting there for room—hundreds more fling themselves on the struggling mass, and numbers perish. And what we see in this tiny drop may be seen on many a fine day in summer in the pools on the shore, where the green scum collects, always densest on the edge that gets the sun.

The advantage of this love of light is obvious. If any misguided spore hated the light, it would settle in the darkest corner of the pool, and, on beginning to grow, would perish miserably from lack of that food-stuff—starch, sugar—which it is unable to work up without sunshine.

It is an exceedingly interesting fact that the brown *Ectocarpus* described above produces swimming bodies which *appear* to be identical with those of *Cladophora* (Fig. 5). But while some of these can grow at once into new plants, others unite in pairs, and, therefore, act as sexual elements. Here, therefore, we see the very beginning of that sexual process which is so marked a feature in the brown seaweeds and the red.

In Ectocarpus there is no apparent difference between the male and the female cells ; but inasmuch as it is a distinct advantage for a cell from which a new generation will spring to be possessed of a store of food material, we find in the higher brown seaweeds the large, inactive female, or egg cell, which has been already described, while the male cell remains minute and active. In the red seaweeds the female organ puts out a special hair-like cell which projects into the water, and intercepts the male cell. This last is, strange to say, destitute of cilia ; it is swept about in the water until by good luck, it reaches its goal.

Such are some of the delights that await the field botanist on the shore. The seaweeds appeal to his artistic, poetic, scientific, and speculative faculties. We see in them life in some of its lowliest aspects, feeling its way up to greater utility, greater beauty (which is more perfect the more it is associated with utility), and to habits and customs that make for greater success

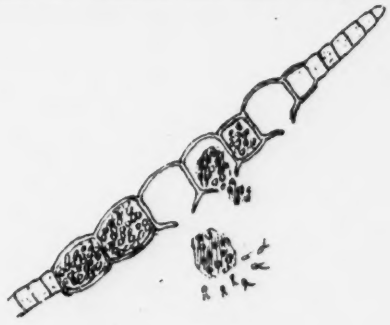

Fig. 5.

in life. Life, we repeat, at its lowest. They have no eyes, yet they see ; no nerves, yet they feel ; no muscles, yet they move ; and they exhibit in simple fashion that passion which, in its highest exemplifications, is described as "tender." In the protoplasm of which their bodies are built reside all the possibilities of life. Our own bodies are built up of and by protoplasm ; and we ourselves can do very little more than the seaweeds that dwell on our shore.

Answers to Correspondents.

Mrs. Jolly.—REFLECTED SUNLIGHT.—The light of the sun, which is estimated to be some 3½ times as bright as that of an electric arc light, is so intense that when reflected off the surface of the moon it causes the latter to "shine." Various surfaces reflect light in different degrees. Thus a window pane, even many miles away, will reflect the sun in dazzling brilliancy, and the sun shining on snow causes so great a glare as to necessitate the wearing of dark goggles.

H. Christopher.—DARK STARS.—You suggest that such bodies "belong, of course, to our solar system." We believe that no such assertion has been made by astronomers. The dark stars referred to are supposed to exist in space, but far beyond the distance at which they would reflect the sun's light. In our next issue we are hoping to insert an article by Mr. Gore, which refers to this subject.

XUM

Some New Discoveries in the Field of Radio-Activity.

By DR. ALFRED GRADENWITZ.

PERHAPS no field of modern physics is being so intensely investigated as is radio-activity, and none has gained such popularity, even with those who generally are strangers to natural philosophy. The phenomena in question, which were originally attributed only to some exceptional class of bodies, have recently been found to be common to any one of the bodies, either inorganic or organic, contained on earth.

Dr. Th. Tommasina, of Geneva, Switzerland, who is one of the pioneers in this branch of science, has lately discovered a special kind of radio-activity which he calls *pyroradio-activity*; this is the radio-active power taken by a wire charged with negative electricity, as it is heated. Such a wire will induce radio-activity in any substance submitted to its action, so that a means of activating these without the help of radium is thus forthcoming.

On continuing his researches on these lines, Dr. Tommasina, however, soon discovered a method of imparting radio-activity to a substance of any description. In fact, on account of the peculiar electric state or *ionisation*, as it is called, produced by X-rays in the surrounding medium, any substance placed in the latter will become radio-active.

It is thus sufficient to have at one's disposal any suitable outfit for generating X-rays, to impart to any substance a fairly strong radio-activity which may last for some days. Even living organisms are liable to be radio-activated without suffering any trouble, as the Röntgen rays need not strike the subject. The Röntgen bulb may, for instance, be located in a cabinet left ajar, the rays being directed towards its interior, so that the "ionisation" of the air is propagated gradually by diffusion.

This opens up a field to a possible medical application of radio-activity, which the necessity of using radium, or other radio-active bodies (exerting effects highly prejudicial to the skin), had so far prevented.

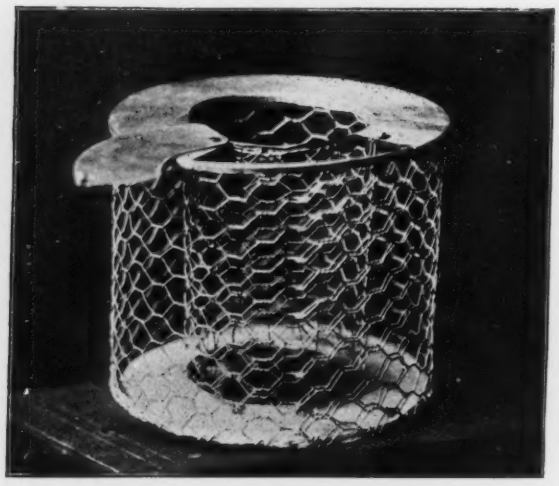

Fig. 1.

In fact, patients can now be activated without any trouble to them, and even while in bed, it being sufficient to place the latter on insulating supports, and to connect the patient to the inner armature of a Leyden jar, the outer armature of which is grounded, as is the positive terminal of the induction coil. Between the

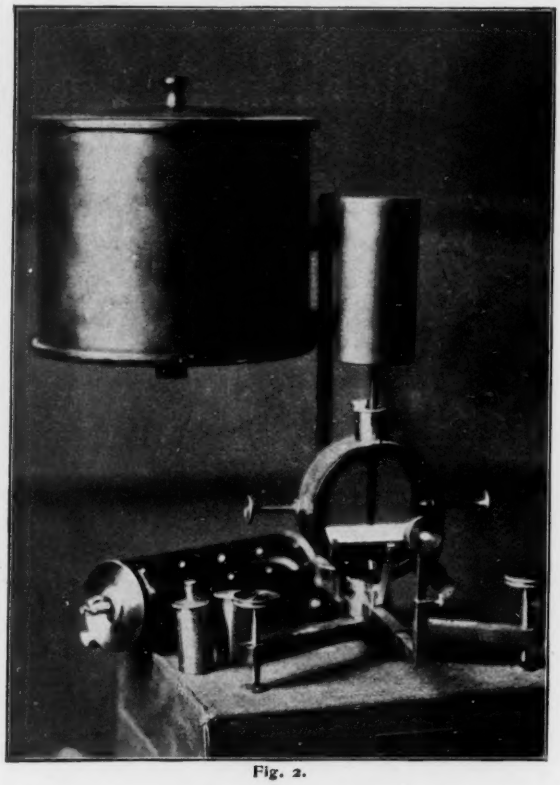

Fig. 2.

negative terminal of the induction coil and the inner armature of the Leyden jar, rapid electrical discharges are allowed to pass. By this means a fairly strong radio-activity can readily be produced.

Any solid body, both inert and organised (such as fruit, grass, and live animals), as well as any kind of conductive or insulating liquids, have thus been made radio-active. Any drugs, both for internal and external use, and any material used for bandages, compresses, etc., as well as any solid or liquid food intended for a special diet, may furthermore be radio-activated by this method without introducing any trace of radium or a similar radio-active body.

As regards the therapeutical properties of this radio-activity, nothing definite can, so far, be stated; any such phenomena are, however, found to be attended by "ionisation," which is favourable to electrolysis, and may even give rise to it. In that case a rather welcome action with a view to a rapid and complete assimilation of certain medicaments, such as iron in the cure of anæmia, might be anticipatd. Moreover, radio-activity being apparently the cause of the therapeutical properties of certain mineral waters, these may be augmented by increasing their radio-activity on the lines above mentioned.

In connection with the above experiments, Tommasina noted that, apart from the temporary radio-activity which may be imparted to animals and plants,

some of them possess a slight permanent radio-activity of their own. This is the case of any freshly-gathered plants and their parts, such as grass, fruit, flowers, and leaves, while the same plants, after being dried, show, at most, some slight traces of temporary radio-activity.

In order to ascertain whether animals also have such a permanent radio-activity of their own, Tommasina constructed a muff-shaped cage of wire grating, forming two concentrical cylinders between which an annular space of some centimetres was left free (Fig. 1). The two cylindrical wire grates were closed both at the top and below by metal discs perforated in the centre to allow of the cage being slipped readily over the insulated metal cylinder of the Elster and Geitel apparatus, serving to measure the radio-activity. On the blackened cylinder of this electroscopic outfit takes place the dispersion of electricity due to the radiation from the animals put in the cage; as the latter has the shape of a narrow circular corridor, the

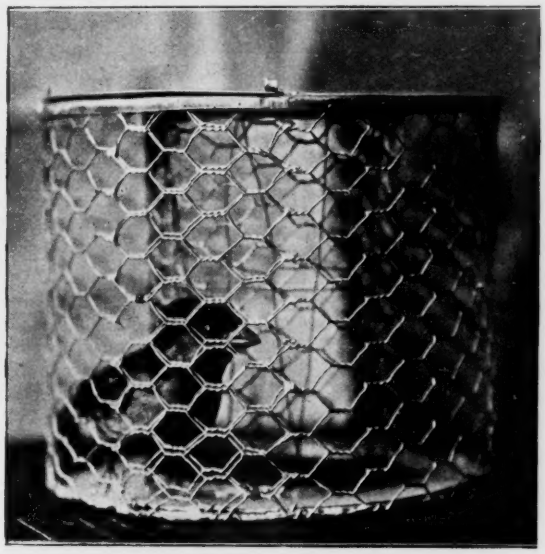

Fig. 3.

animal is allowed to move freely while remaining always at practically the same distance from the electrified dispersing cylinder (see Fig. 3). The cage containing the animal experimented on is next placed in the interior of the great cylindrical metal cylinder seen on the left of Fig. 2; this is blackened both within and without, so as to eliminate any dispersive action of ultra-violet rays.

Though these highly interesting experiments on the radio-activity of birds had to be discontinued temporarily, Dr. Tommasina was able to state that the phenomenon is quite general in character. The most interesting result is, however, that the intensity of the radio-active radiation is stronger with grown individuals than in young ones, and depends also on the state of activity or rest of the subject. In fact, *radio-activity seems to be proportional to muscular activity or vital energy.*

This phenomenon, that could be called *bioradio-activity*, has doubtless a rather intimate relation with life, and from this point of view its further investigation will probably give results of a great bearing both on philosophical and practical problems.

CORRESPONDENCE.

The Equation of Time Theory.

TO THE EDITORS OF "KNOWLEDGE & ILLUSTRATED SCIENTIFIC NEWS."

SIRS,—In your number for August, a question is put to me by your reviewer in his observation upon the first part of my work, "Some Elements of the Universe Hitherto Unexplained." I am sure you will permit me to reply, the more especially as the question of your reviewer raises an interesting issue upon the subject. The question has relation to Chapter IV., which asserts that the existing theories do not account for the cause of the sun's irregularity in time, and furnishing a new explanation. The question of your reviewer is —"How would he deal with an obliquity of 90°?"—meaning, I suppose, if the obliquity of the ecliptic were 90°, instead of as at present 23° 27' 5"92. To answer this it is necessary to use the reputed effect of the present obliquity as the basis for gauging the effect at 90°. To limit my reply as much as possible, I will confine my remarks to the 30° immediately following the March equinox. The advantage of taking these 30° is that the theoretical causes of the sun's irregularity are here all acting in the same direction, if they act at all; and the sun is at its average distance, the actual mean occurring on April 1. If a celestial globe be referred to, it will be seen that the distance along the ecliptic from the equinox to meridian 30 is just over 32 degrees of arc, or 2° more than along the equator. If the obliquity were increased to an angle of 45°, it will be found that 8° is added before the 30th meridian is reached. At an angle of 70° the extra distance is 27°; at 80° it is 41°; at 85° it is 50°; and at 90°, to make up the full arc of 90°, it is evident that 60° is required. Traced in this way, it is seen that if the present obliquity has an effect, the increase would continue up to 90°; it would then decrease in the same ratio. What then would be the result of moving the ecliptic the extreme limit of 90° from the equator, or at right angles to the equator? At the equinoxes the axis of the earth would be parallel to the equator. Still there would be 12 hours day and 12 hours night, just as now. But at the December solstice the south pole of the earth would point to the sun, and at the June solstice, the north pole on June 21, the sun would be almost stationary in the mid-heavens. But it would begin a small spiral, and by noon next day would cross the 180th meridian about one degree from the north pole. The following day it would apparently describe a slightly larger spiral, and continue to increase the spiral day by day, and also to cross the 180th meridian with an advance at the same rate that it now moves along the ecliptic. As the obliquity of 90° results in this small circle in the sky at the solstice (during which the sun will pass over less than 6° of arc), will it occupy a less period of time than the circle twice the size next day, or any of the increased circles up to the time of the sun reaching the equator and passing round the whole 360°—or more than 60 times the arc distance of the small circle. It is evident that all will occupy the same time, because the sun does not move, but the appearance of its movement is due to the revolution of the earth, and no variation can be detected in that. It is thus seen what a valuable argument the question of your reviewer supplies against the existing theories, because the placing of the ecliptic at right angles to the equator not only shows that at the greatest possible angle no difference is made in the causes said to produce the sun's irregularity; but by removing the effect of the earth's revolution in its orbit from the effect of its revolution on its axis, it is made plain that although the sun would appear to move from the south pole to the north pole in the course of six months (or nearly nine times its present change of altitude), yet it would not entail any difference in time because it must be performed in the period of the earth's revolution on its axis. The irregularity in the sun's motion, due to causes which I explain in my work, would not be affected by the change of obliquity, and would be indicated by a variation in its latitude. If the Cæsar of obliquity be appealed to, let the decision be according to what is claimed. In the period the sun ought to move from the equinox to meridian 30; if its motion be measured along the line of the ecliptic, it must be more than 2° behind time. Two degrees means nearly two days, or 1 hour 36 minutes per day.

XUM

That is, the amount of obliquity causes the sun to be slow, or it has no effect. Can anyone explain away these two days if they exist or show that any cause is operating to reduce them? I would like to touch upon other points, but fear I have exceeded allowable limits.

August 17, 1905. A. BALDING.

[By the courtesy of the Editor I have seen Mr. Balding's letter, and I at once admit that my supposed challenge was a little hasty, since an obliquity of 90° is a sort of paradox, and its effect would be less obvious than that of an obliquity of *nearly* 90°. Apparently, however, Mr. Balding fully realises the sort of effect to be expected. The appeal to Cæsar may stand, and we may admit the approximate accuracy of the 2°. But two degrees will not mean two days, as Mr. Balding imagines, since, as he himself allows, the motion is not that of the sun but of the earth, so 2° means about 8 minutes of time, or 16 seconds (roughly) per day. A very different matter to his 1 hour 36 minutes.—THE REVIEWER.]

Eoliths.

TO THE EDITORS OF "KNOWLEDGE & ILLUSTRATED SCIENTIFIC NEWS."

SIRS,—A recent experiment in France is reported whereby so-called Eoliths were produced by mechanical means; the impression caused by the report is likely to lead to some discussion on the nature of Eoliths. It appears that certain French authorities visited a cement factory at Mantes for the purpose of examining certain stones chipped during some mechanical process whereby flints are separated from the chalk matrix. At the conclusion of the process they were astonished to find "that the great majority presented examples of all the Eolithic forms." On this point of similarity it is necessary to suspend opinion, but the observers have, as a result, abandoned all conviction that Eoliths had an artificial origin. No one doubts that stones somewhat resembling Eoliths can be produced by natural processes—the Mantes process it should be borne in mind is not a natural one—but at the same time there is a distinction to be drawn between them and true Eoliths. Again, with all respect to Continental observers, it may be said that much of what is there accepted as of human origin would here be rejected as too indefinite. In what way it can be shown that the Mantes mechanical process resembles the action of the rivers in depositing the plateau or any other gravels is difficult to understand. We are told that the flints and the containing chalk blocks are placed in a receiver full of water, and then rotated to effect separation; but here is no parallel of action, as in the separating process the materials are strictly confined within the receiver. We are further informed that the majority of flints thus separated show work of seeming Eolithic type. In this feature the plateau gravel compares unfavourably with the Mantes process, for in the former the worked stones form but a small proportion of the whole. It should be remarked that unrolled Eoliths often occur with rolled flints, and that the clayey nature of some plateau gravels preclude the necessity of supposing a violent type of deposition; in fact, the presence of this clay serves to show that in some cases deposition went on in a tranquil manner, or under circumstances not favourable to the abrasion of flints. How, it may be asked, can the presence of *unrolled* Eoliths in this clayey drift be explained away other than by suggesting that they were dropped near these ancient streams and subsequently covered by the containing clay?

Under any circumstances the Mantes pseudo-Eoliths do not dispose of the evolutionary contention for a period when man had not arrived at the Palæolithic stage of his culture. Professor Boule and Dr. Obermaier will shortly discuss these pseudo-Eoliths, when they will doubtless give reasons for the contention that a modern mechanical process can be admitted as evidence against the human origin of Eoliths.

That natural agents can fracture flints is admitted, but the nature of the fracturing may be said to bear with it its own explanation; another explanation is demanded by the definite types of Eolithic implements. For this reason, then, all students of these early forms will await with interest the advent of these pseudo-Eoliths from the Mantes cement yards.

Chelsfield, Kent, Yours faithfully,
August 17, 1905. J. RUSSELL LARKBY.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Sensitisers.—The action of certain dyes and similar organic substances as sensitisers for photographic plates, especially for conferring increased sensitiveness to green and red light, is so well known that it is interesting to note the effect of similar bodies when added to other light-sensitive substances. Messrs. H. Calmels and L. P. Clerc (*Le Mon. de la Phot.*, July; Abstract, *Jnl. Royal Phot. Soc.*, August) have experimented in this direction with bichromated gelatine and albumen, as used in photo-mechanical work (making process blocks). One sample of erythrosin doubled the sensitiveness of a gelatine film, another increased it to three times, while a sample of eosin made it four times as sensitive as when untreated. From two to four grams of the colouring matter to each litre of the prepared bichromated solution of gelatine or albumen is about the maximum quantity, and when more than this is added the sensitiveness of the resulting film is decreased. Messrs. A. Jodlbauer and H. V. Tappeiner (*Ber.* p. 2602; Abstract, *Jnl. Soc. Chem. Ind.*, p. 903) find that the sensitiveness to light of a solution of mercuric chloride and ammonium oxalate (as used in photometry) is increased by the addition to it of certain fluorescent substances, including fluoresceïn and its chlorine, bromine, and iodine derivatives. It would be interesting to know the character of the added sensitiveness in these cases, whether the substances used are "colour sensitisers," as the expression is used in relation to gelatine and collodion plates. But, in any case, until it is shown to be otherwise, a broad distinction must be made between the effects just referred to and the sensitising of silver salts, because, in the one case, it is a definite chemical change that is quickened, while in the other the change is presumably not chemical at all, though, further than this, nothing is known of its real nature.

The Principles of Development, etc.—The recent communications of Messrs. Sheppard and Mees deal with matters that have an important bearing upon photographic procedure, and from them I have gathered the following results and conclusions. It must not be supposed that these results can be applied without modification to all circumstances that appear to be similar to those stated, as investigators cannot be held responsible for the modifications that plate-makers may see fit to introduce into their formulæ, or photographers into their methods. The plates used were, I believe, specially prepared by coating plate glass with a simple emulsion containing less than one per cent. of silver iodide, and the minimum of soluble salts.

The quantity of silver that is found in 100 square centimetres of film after exposure and development to give a "density" (opacity logarithm) of unity, the authors find to be .01031 gram as a mean of several experiments. Eder had previously obtained the same figure, but Hurter and Driffield found .0121, and subsequently, .0131 gram. The authors suggest that this discrepancy is due either to a constant error in Hurter and Driffield's photometer, or else to the plates used. I believe that it is a common experience with plate-makers that very much more silver is necessary to give density in a quick plate than in a slow one. From this, and other considerations, I should have expected

this figure to vary considerably, according to the character of the plate.

The discrepancies obtained in the results of measuring plates similarly exposed and developed gave in three series of experiments 3.2, 2.2, and 6.0 per cent. as the greatest deviations from the mean density in each case. These errors, due to the plates, were obtained by the use of an emulsion specially coated on to plate glass, but not by means of the apparatus the authors have since constructed for coating experimental plates.

Concerning the velocity of development with ferrous oxalate, the authors find that (1) the silver is deposited at first with increasing rapidity, then more slowly, tending to a limit that depends only on the exposure, (2) the velocity is proportional to the concentration of the developer, but that this relationship is liable to be interfered with by the accumulation of the products of the reaction in the film, (3) a soluble bromide reduces the velocity, but the reduction becomes less as the action proceeds, (4) as the bromide is increased in geometrical proportion the velocity diminishes in arithmetical proportion, (5) hardening the film is without effect on the velocity of either developing or fixing, even when a four per cent. solution of formaldehyde was applied until the film was insoluble in cold water, (6) the velocity of development varies with different plates, and diminishes for a given plate as it gets older, (7) the velocity depends mainly on the rate of diffusion of the developer.

Concerning the grains of silver and their disposition in the film, the authors find that (1) by short development the depth to which the image extends is independent of the exposure (I suppose in the absence of soluble bromides), but that finally it becomes a maximum for each exposure; (2) by exposing through the glass, still the grains most exposed begin to develop first; (3) the size of the grains increases during development until finally it is independent of the exposure; (4) the addition of bromide causes a diminution in the size of the grains.

Many of these conclusions are in full agreement with the everyday observations of photographers, and the results of previous investigators. It will, however, doubtless surprise many to learn that the velocity of development and fixing is not affected by the hardening of the film.

Mr. Sheppard has also published in the Journal of the Chemical Society for August a communication on development as a reversible reaction, and on the retarding action of soluble bromides. I have refrained from referring to anything stated therein, because, as the author says that it bears on many points in photographic practice, he will, doubtless, shortly indicate its practical importance himself. But I would remark on the fact that in using the word "reversible," he does not appear to consider the difference between develop able and non-developable silver bromide. The silver bromide is reduced by the developer, because it is in the developable condition, undevelopable silver bromide not being reducible under the same conditions. When the reaction is reversed, the resulting silver bromide would, I suppose, not be likely to be in the developable state.

The Royal Photographic Society.

THE annual exhibition of photographs was opened on the 20th of September at the New Gallery Regent Street, and will remain open until October 28th. The large collection will be found of considerable interest to photographers. Amongst other items of scientific interest are some fine specimens of X-ray work, and some examples of three-colour printing.

NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Nova Aquilae. No. 2.

IN a telegram circulated from the Kiel Centralstelle, Professor Pickering announced that Mrs. Fleming had discovered a new star from examination of plates obtained at the Harvard College Observatory. The star was situated near λ Aquilae, and was stated to be fading rapidly at the time of discovery, September 1.

The position first circulated was

R.A. = 284° 2′ = 18h 56·1m.
Decl. = − 4° 34′;

but a later wire gave a more accurate value of the right ascension as R.A. = 18h 57m 8s.

By September 4 several visual observations had been made. Professor Max Wolf reported that at Heidelberg the star was observed on September 4, the magnitude being then about 9·3. The position was determined to be:—

R.A. = 18h 54m 24s
Decl. = − 4h 39m
(Epoch 1855). 1905, Sept., 4d 9h 30m Koenigstuhl Mean Time.

On September 6, Dr. P. Guthnick telephoned that he had been able to observe the new star at the Bothkamp Observatory, and giving its position to be:—

R.A.	Decl.	Epoch.
H. M. S.	° ′	
18 54 25	− 4 38·8	1855·0
18 57 4	− 4 34·8	1905·0

The magnitude on September 5 was about 10·2, and the colour greenish yellow.

Beginning of the New North Polar Cap of Mars.

An interesting observation was made at the Lowell Observatory, Flagstaff, Arizona, on May 19, 1905, which determined the important fact of the definite time of formation of the new north polar cap of the planet Mars. A large white patch was first noticed south and west of the old polar cap, and it was quite certain that nothing of the kind was visible the day before. The season would correspond to that about August 20 with us. In extent the area of the new patch was enormous. On the 20th the white patch was again visible and showed a brilliant kernel at its southern end in longitude ± 70°.

The date of this formation was 126 days after the summer solstice of the Martian Northern Hemisphere, and it is very important to note the agreement of this value with that first determined in 1903, which was given at 128 or 129 days after the northern solstice, as this shows evidence of constancy of meteorological cycles on the planetary surface.

Further Observations of Jupiter's Seventh Satellite.

From a telegram circulated by the Kiel Centralstelle, we learn that Professor Albrecht has obtained another determination of the seventh satellite of Jupiter, with the Crossley Reflector of the Lick Observatory, as follows:—

	Position Angle.	Distance.
1905, Aug. 7.96 G.M.T.	289°·7	54′·6

In the Lick Observatory Bulletin, No. 82, a set of elements for the satellite are given by F. E. Ross, computed from the observations by Perrine, on January 3, February 8, and March 6, 1905.

XUM

ECLIPTIC ELEMENTS.

Mean Jovicentric Longitude at Epoch	333·55	1905. Jan. 0·0 G.M.T.
Longitude of Perijove	336·65	
Longitude of Node	237·23	
Inclination to Ecliptic	31·0	
Inclination to Jupiter's Orbit	32·0	
Longitude of Node on Jupiter's Orbit	238·6	

ELEMENTS REFERRED TO EARTH'S EQUATOR.

Mean Jovicentric Right Ascension	328·18	1905. Jan. 0·0 G.M.T.
Right Ascension of Perijove	331·28	
Right Ascension of Node	281·13	
Inclination to Equator	26·2	
Mean daily motion	= 10·358	
Log. a	= 8·9004	
a	= 52′·54	
e	= 0·0246	
Period	= 265·0 days.	
Distance at maximum elongation	= 70′.	

It is thought that the combined observations of the sixth and seventh satellites will furnish material for a new determination of the mass of Jupiter, which should be comparable in accuracy with the best results hitherto obtained.

EPHEMERIS FOR OBSERVATIONS OF JUPITER'S SEVENTH SATELLITE

Greenwich Mean Noon.	Position Angle.	Distance.
	°	′
1905 October 4	290	59
9	289	58
14	289	55
19	288	51
24	287	46
29	287	40
November 3	285	33
8	284	26
13	283	18

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Commercial Phosphorus Sulphide.

THE terrible effects, notably the decay of the jaw bone, produced by the ordinary white phosphorus upon the workpeople in the match factories have led to many attempts being made to find a satisfactory substitute. The red modification of phosphorus is non-poisonous, and does not produce the physiological effects of white phosphorus, but has the drawback of not being ignited by friction, while the scarlet modification discovered by Dr. Schenck has not yet come into general use, although it appears to be non-poisonous and yet chemically active. In the national match factories in France a sulphide of phosphorus has been used for several years for the tips of matches that will strike anywhere; and it is stated that the disease is now unknown there. It is most essential, however, that the sulphide should be quite free from white phosphorus, and M. Leo Vignon has therefore made experiments as to the best means of detecting it. He finds that the commercial product usually consists almost entirely of phosphorus sulphide, P_4S_3, and contains about 1 per cent. of free phosphorus which is of the red modification, and therefore harmless. The only test that gives satisfactory results is to pass a current of hydrogen over the product, when in the presence of white phosphorus the gas becomes phosphorescent in the dark, and will burn with a green flame, yielding phosphoric acid, which can be identified by well-known tests.

An Anti-Serum for Hay Fever.

The hay fever of Europe is, as is well known, caused by the pollen of a large number of plants—notably grasses; while the widespread and more serious "autumnal cold" of North America has been traced to the pollen of the rag weed (*Ambrosia*), and also of certain asters and chrysanthemums. The whole question has been thoroughly investigated by Professor Dunbar, of the Hygienic Institute of Hamburg, and a simple method of serum treatment devised. A substance of an albuminous character could be isolated from each of the active pollens by extraction and precipitation with alcohol and salt, and this substance produced all the symptoms of hay fever in susceptible individuals. Unlike the true toxines produced by many pathogenic bacteria, it was not destroyed by heat, and could also resist the action of dilute acids and of the ferments of the digestion, though it was sensitive to the action of alkalies. Different individuals varied as regards their susceptibility to its action; but as a rule a dose of $\frac{1}{1000}$ to $\frac{1}{2000}$ of a milligramme was sufficient to produce all the local toxic effects. An anti-serum was obtained by inoculating rabbits with this preparation, and the immunised serum thus prepared neutralised the poison outside the body, and in practice protected susceptible subjects against the pollen. It is now sold as a commercial preparation under the name of *pollantin*, either in the liquid state or in the form of a powder, obtained by evaporating the serum in a vacuum. It is only intended for external application, for although subcutaneous injection does afford some protection, the immunity is only partial, and does not last more than a few days at most.

The Composition of Soot.

Mr. E. Knecht has examined numerous specimens of soot of various origin, and especially that from the Manchester chimneys. This was found to contain about 11 per cent. of ammonium sulphate, 20 per cent. of other mineral matter (ash), and 13 per cent. of substances soluble in benzene, the residue (46 per cent.) being assumed to be carbon. The substances soluble in benzene were hydrocarbons of high boiling point, while the insoluble residue was a brownish highly inflammable powder, taking fire spontaneously when heated to the temperature of boiling water. Extraction of the soot with alkali yielded a brown product, from which a dyestuff could be prepared, giving fast shades on cotton, ranging from fawn to dark brown. London soot contained a very much smaller amount (1·3 per cent.) of substances soluble in benzene, while soot from Prague (lignite coal) yielded only 0·2 per cent. of these substances and contained only traces of ammonia.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

Niagara's Horse-power.

According to a recent survey of United States engineers, the Niagara River in its course from Lake Erie to Lake Ontario falls a distance of 327 feet, and discharges 230,000 cubic feet of water per second from one lake to the other. At the same time it develops an equivalent of about 9 million theoretical horse-power, of which 50 per cent. is estimated to be available for industrial purposes.

Glaciation of Turkestan.

Evidence of the extension of what we know as the Glacial Period accumulates. Mr. Ellsworth Huntingdon, in "Explorations in Turkestan" (Washington), claims for the neighbourhood of his explorations as many as six advances and six interglacial withdrawals of the ice, basing his claim on the phenomena exhibited by those valleys which still contain glaciers in them. The idea that the Glacial Period was confined to any one portion of the globe is vanishing before the advance of geological science, and Croll's so-called astronomical theory no longer gives an acceptable explanation of the phenomena of the age.

Black Gault.

In the process of excavating for drainage in the village of Ditchling, in Sussex, three pits have been dug to a considerable depth, each pit being separated from the next by about 200 yards. At a depth of 10 feet, black carbonaceous clay has been reached, so thickly impregnated with black vegetable matter as to constitute a soft lignite. The base has not been reached, but it extends to at least a thickness of 15 feet. The village is situated about a mile north of the chalk escarpment, and the outcrop of the gault clay is midway between the hills and the village. The black mud is covered with what is probably the wash of the lower greensand beds of the higher ground somewhat farther to the north, and no doubt represents a basement-bed of the gault clay. It promises to yield a large quantity of water, should it at any time be necessary to utilise it for the purpose.

XUM

White Tertiary Limestone at Herne Hill.

In my collection are some pieces of hard white limestone which I collected some time ago in what is now the end of Rosendale Road, Herne Hill, when excavations were being made for house-foundations. Tertiary limestones are, of course, not unknown in our country, the Isle of Wight Oligocene beds being instances. I do not remember, however, having seen any reference to Eocene limestone in the neighbourhood in question, and the point seems to be worthy of record. Some of the rock was so hard as to have necessitated the use of the pick and crowbar in its excavation, and resembled the "Chalk Rock." Some portions were to some extent siliceous, whilst others bore a close resemblance to ordinary chalk. The stratum was fairly extensive, and, so far as one can judge from the work of the Geological Surveyors, it probably forms a stratum of the Woolwich and Reading series.

Mammals in the Wandle Valley.

Amongst the Mitcham gravels the following Pleistocene remains have been found, and are to be seen in the Croydon Town Hall: Tooth of Mammoth Calf (*Elephas primigenius*); tusk of ditto; bones of *Bos primigenius*; bones of horse (*Equus caballus*). In the Thornton Heath gravels have been found five teeth and numerous fragments of bones of *Elephas primigenius*. These are preserved in the Grange Wood Museum, together with 5 feet of a tusk from the Mitcham gravels.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Bird Outlaws in Norway.

BIRDS of prey in Norway are apparently kept under with a stern hand. The *Field* of August 26 contains a list of carnivorous mammals and birds upon whose heads a price is set by the Government. Last year head-money was paid for 108 eagles, 130 eagle owls, 93 gyr-falcons and peregrines, 437 goshawks, 880 sparrow-hawks, and 1034 divers. We cannot congratulate the Norwegians on the war of speedy extermination which they are prosecuting.

Montagu's Harrier in Northumberland.

Mr. Abel Chapman, in the *Field* of September 2, writes to protest against the "brutal and selfish" destruction of a Montagu's Harrier (*Circus cineraceus*) on the Moors of Coquetdale, Northumberland, in August last. This bird, a female, had apparently haunted these moors for some weeks only to be shot at last by a gamekeeper. Mr. Chapman writes with some warmth on the matter, and we most heartily endorse his remarks.

Hen Harrier in Norfolk.

A male and female hen harrier (*Circus cyaneus*) were shot (*Field*, September 9) "during the last few months—the one at Snettisham, the other at Wolferton—while quartering the marshes." Both were immature birds.

White Stork in Norfolk.

The *Field* of September 9 records the occurrence of a white stork (*Ciconia alba*) at North Wotton. Of course the bird was shot, and proved to be an adult male in full plumage.

Great Snipe in Shropshire.

An immature specimen of this species is recorded by Mr. E. G. Potter in the *Field* of September 9 as having been shot at Prees, near Whitchurch, Salop. The sex of the bird is not stated, but the weight was 6¾ ozs.

Dusky Redshank in Kent.

The *Zoologist* for September records the shooting of a pair of Dusky Redshanks (*Totanus fuscus*) at Jury's Gapp, Lydd, on May 29, both birds being in summer plumage.

Squacco Heron in Kent.

A specimen, fully adult (sex not stated), was shot in a grass field at Rye, Sussex, according to the *Zoologist* for September, on June 3. This makes the forty-first authenticated occurrence of the species in Great Britain.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

An Electrical Experiment.

PROFESSOR WORTHINGTON, of the Royal Naval Engineering College, Devonport, has recently tested whether any difference can be detected between space which is at a high electric potential and space at a low potential quite irrespective of the existence of any electric field in the space in question. In explanation of this last proviso we may remind the reader that electric force arises whenever there is a difference of potential between two points; so that the absence of electric force implies that the experiment must be so performed that the electric potential has a uniform value. Use is made of the fact that the potential inside a closed conductor is uniform. Two such conductors, consisting of long tubes of semi-circular section, were placed with their flat sides separated by a sheet of ebonite only. These tubes were connected to the knobs of a Wimshurst machine, and when the machine was excited the space inside one of them would take a high positive potential —practically uniform throughout it—whereas the other space would have a much lower (or negative) uniform potential. The experiment consisted in looking for a possible effect of the potential upon the velocity of light. An ordinary interference device was employed, *i.e.*, light from a single source was split into two beams, one of which passed down one tube, the second down the other. These beams were then brought together again by a telescope lens, and in the overlapping region interference bands are observed. If the effect of the high potential is to increase the velocity of light then these bands will shift. "When care was taken not to touch either table, no shift whatever could be detected either when the spark occurred or while the potential difference was accumulating." The spark referred to was at the adjustable knobs of the machine, which were kept 1½ inches apart. This distance determined the maximum difference of potential, viz., 60,000 volts; the length of the tubes was 152 cms. Assuming that a shift equal to one-twentieth of a band could have been detected if it had occurred, it follows from its absence that if there is a difference of velocity it is less than $\frac{1}{3}$rd of one-millionth of the velocity itself.

Ether-drift.

Prof. Brace has recently extended the tests on a possible influence of ether-drift on rotary polarisation using oil of carraway seed instead of quartz, and concludes that the effect of the motion of the earth on the rotation in active substances is certainly less than one part in five million, and probably less than one part in ten million of the total rotation.

The Future of Science.

In an interesting article in the July number of the "Popular Science Monthly," Professor Dolbear asks, "Is there no more work for the man of science? Are there no more problems of importance awaiting the investigator? Have we all the knowledge we are likely to get? There are some who, having noted the prodigious product of the nineteenth century, have half feared that science has been worked out." We would point out that a glance at almost any scientific journal should act as a tonic to any one who may be taking a depressed view of the situation. It is not a distant retrospect that we must make in order to reach a period of scientific prosperity. There probably never was a time in which greater advances were being made than the PRESENT. Professor Dolbear, however, is not himself a pessimist. He asks the question merely as a preface to some suggestions of his own as to future lines of research. We select one paragraph only: "When the ether is understood we shall be able to understand, in a mechanical sense, how moving a magnet disturbs every other magnet wherever it may be; why chemical compounds are possible; why crystals assume geometrical forms; and why cellular structure in plants and animals can embody what we call life."

XUM

ZOOLOGICAL.

By R. LYDEKKER.

The Pen-Tailed Tree-Shrew.

BORNEO has hitherto been supposed to be the sole habitat of a very remarkable little animal known as the pen-tailed tree-shrew (*Ptilocercus lowei*). The creature is a near ally of the tupais, or tree-shrews, of the Indo-Malayan region, but is very small, and has an exceedingly long cylindrical tail, which, instead of having a fringe of long hairs on opposite sides throughout its length, is furnished merely with a vane of such hairs near the tip. Recently a specimen has been taken in the Selangor district of the Malay Peninsula. Since the long-nosed crocodile known as Schlegel's gharial (*Tomistoma schlegeli*), which was also long supposed to be confined to Borneo, has likewise been discovered in the Malay Peninsula, it is evident that the fauna of these two areas has more in common than was formerly supposed.

A Giant Pig.

From the later Tertiary deposits of Nebraska has been recently described the fossilized remains of a gigantic fossil pig, which has been named *Dinochœrus hollandi*, in honour of the Director of the Carnegie Museum, who recently brought the *Diplodocus* skeleton to the British Museum. Some idea of the enormous size of this monster will be gathered from the fact that its skull alone measures nearly a yard in length.

The "Siruku."

The Mandingos of Liberia, according to Sir H. H. Johnston, "talk a great deal about a striped animal which they call siruku. They recognised a picture of a zebra, and called it siruku, but at the same time described the animal as being extremely ferocious and dangerous to life. As it is impossible to recognise this description as applying to the zebra, I thought from their gestures that they might mean the leopard; but to the leopard they gave a totally different name—soli. Moreover, they were particular that this animal had stripes. It may be the striped hyæna. At the same time, on every occasion when they were shown the pictures of a zebra they declared that this was the creature they called siruku, but that in their country it was ferocious." Even if the siruku be the striped hyæna, it will indicate an animal—possibly a distinct race or species—new to the West African fauna. In India, at any rate, striped hyænas are skulking cowardly brutes, which never voluntarily attack man; but this scarcely accords with the character given to the mysterious Liberian animal.

A Gorilla at the "Zoo."

The menagerie in the Regent's Park has received a fine female gorilla, imported from French Congo-land, in company with no less than seventeen young chimpanzees. On arrival at the docks, the gorilla was reported to be in fair health, although suffering from its somewhat restricted quarters on board ship, and since its transference to the Regent's Park has apparently done well. It is the largest specimen imported of late years.

Bubble-Nesting Fishes.

Most, if not all, of the fishes allied to the celebrated "climbing-perch" (*Anabas scandens*) have the remarkable habit of constructing "nests" or floats of bubbles, in which their eggs are placed during the period of development. All these fishes are brilliantly coloured, and, with the exception of one African species, are natives of the Indo-Malayan rivers. Among those definitely known to make floats of this nature are the gourami (*Osphromenus olfax*), renowned for the excellence of its flesh, the paradise-fish (*Polyacanthus opercularis*), and the fighting-fish (*Betta pugnax*), so-called on account of a domesticated breed being kept for fighting by the Siamese. Specimens of the two latter have recently been kept in aquariums by an English naturalist, where they have constructed their bubble-rafts, which are more or less dome-like in shape. In the case of the paradise-fish, the layers of bubbles, which are blown by the male fish, are gradually increased, and to such an extent that the eggs are raised above the level of the water, in which position they are hatched.

REVIEWS OF BOOKS.

Spectroscopy. E. C. C. Baly, F.I.C. (Longmans; 10s. 6d.).—There is probably no subject for which a new English textbook was more required than that of spectroscopy. The advances made have been so considerable that a mere revision of any existing textbook would have been totally insufficient. In Germany a thoroughly satisfactory encyclopædic handbook is being brought out by Professor Kayser, and this will probably serve as the ultimate book of reference for some time to come. But this is too elaborate a treatise for the ordinary student, even when the language in which it is written does not prove an obstacle. The reproach that there is no adequate English textbook is removed by the present publication, which forms one of the textbooks of physical science edited by Sir William Ramsay, who is to be congratulated on having placed the subject in the hands of one so competent to treat it with distinction. The characteristic feature in the treatment is the fulness in the descriptions of experimental detail, and of the conditions upon which success in spectroscopic measurements depends. The prismatic and diffraction spectra, and the much derided but now victorious interference methods for the determination of wave-lengths are successively described in great detail. It is a pity that the present edition was not in time to make use of Schuster's recent important demonstration of the erroneousness of much that has been written and accepted as gospel on the purity of spectra. The survival of this error vitiates part of what has been written in Chapter X. The student may here be warned that Schuster's original expression for the purity (p. 317) must be accepted in place of the more elaborate (but erroneous) formula of Wadsworth's; and consequently he should alter the formulæ in this chapter accordingly.

Sixty pages are devoted to the means of producing the luminous sources of spectra; and twenty-four to the various kinds producible. Chapter XV. consists of an elaborate and very complete account of the series of lines in spectra and the different formulæ which have been devised to represent them. We miss, though, any reference to Nagaoka's theoretic discussion of the reason of the existence of these series. There is a wide field here in which much has yet to be done; and the full and clear account which Mr. Baly gives will be a very welcome summary of experimental facts to those who are interested in the matter. An outline of present experimental knowledge of the Zeeman effect forms Chapter XIV. It must be understood that the treatment throughout is limited to simple mathematics. It is, of course, impossible to put everything under one roof; and copious references to original sources guide the reader who wishes for fuller information. There are very few inaccuracies. The first account of the ideal grating was given by Schwerd not by Rayleigh; and Newton *did* use a slit; though it is quite common to find it denied of him. In biaxal crystals *neither* ray is, in general, ordinary; the definition of optic axis on p. 96 is imperfect. The logic on p. 155 in connection with resolving power is of the circular type. These, however, are minor matters; and they do not appreciably detract from the great value of this important work.

Structural and Field Geology, by James Geikie, LL.D., &c., author of "The Great Ice Age," &c. (Edinburgh: Oliver and Boyd. London: Gurney and Jackson. Pp. xx. and 435. Price 12s. 6d. net. With 61 full-page plates, and 142 illustrations in the text).—It is a pleasure to call attention to this excellent manual, in which Dr. Geikie has traversed the whole field of the geological world in a manner which must cause it to be of the utmost value, both to the purely scientific geologist and to those engaged in professions in which a general knowledge of the principles of geology is a necessity. While furnishing excellent reading for the general public interested in the subject, it will undoubtedly be useful as a manual to guide the student in the acquisition of exact and accurate knowledge. It is a work, too, which should be in the hands of all engineers who have in the slightest way work to do in which a knowledge of the constituents of the crust of the earth is necessary. The illustrations are excellent, and in the absence of actual specimens of the minerals and rocks referred to in the text, nothing could be better for purposes of the student. As instances, we may mention the section of an agate, on Plate I.; tabular

granite of Goatfell, on Plate XXXV.; columnar basalt, on Plate XXXVII; and dendritic markings on limestone, on Plate XXVII. Students are carefully shown how geological surveying is performed in Chapter XVIII. and succeeding chapters. Dr. Geikie has produced an excellent work which will, if possible, increase the esteem in which he is held by the geological world.

Elementary Experimental Science. W. M. Heller and E. G. Ingold. (Blackie and Son.) This is a book written essentially for teachers and not for pupils. It represents an endeavour to indicate the spirit of the teaching and the method of instruction to be followed in order that the maximum educational efficiency may be obtained from the subject. With the exception of one object lesson on feathers, all the lessons are on physics and chemistry. It would be easy to select other experiments, and any specially intelligent teacher would no doubt do so; but to the more ordinary man who can value the advantage of assistance in this respect the book must be very highly commended. When the British Association met at Belfast, the writer of this notice had the pleasure of being conducted through an exhibition of pupils' work which had been done on the same lines as those described here. The conductor was himself a pupil; and it is unquestionable that in one lad, at any rate, the methods had succeeded in creating a lively interest in experimentation. There was, indeed, one fact which he spontaneously stated that he could not understand; viz., why a small body of water in the narrower limb of a U-tube can balance the larger body in the other limb. We have, therefore, looked up this particular point in the book before us, and we find that the treatment of the subject of fluid pressure is not very clear. The method throughout is the heuristic one—a phrase which as defined in the introduction refers to "carefully directed inquiry." But how can it be inferred from experiment 96 that the earth is subjected to an atmospheric pressure *in every direction* of about 15 lbs. per square inch. The fact implied by the three words which we have put in italics cannot be deduced from the experiment itself; nor can it be from any other of the experiments described. When we have made these criticisms there is none of an adverse nature to make. We cordially recommend the book to every school teacher or to any one who is concerned with the creation of scientific habits of thought in children.

Bird Life Glimpses, by Edmund Selous (London: George Allen, 1905).—This book contains a great deal of "twaddle," and not a little that is akin to nastiness—most decidedly it is not a book that we should care to put into the hands of the young. Detailed descriptions of the act of coition as practiced among birds are not, surely, subjects which should be discussed in a book which has all the outward semblance of a volume designed for the children's library, or the drawing-room. Apart from this, its pages contain a great deal of padding that could well be dispensed with. Such, for example, as the discussions on Art and Psychology, which are irritating. The author here and there condescends to say a kind word for scientific men, and now and then, apparently lest they should become puffed up by such notice, he pokes fun at them—fun of a sort! Occasionally he indulges in a little hypothesis hatching—we venture to think the resulting chicks are destined to fill an early grave. We are sorry not to be able to speak more favourably of the book, for, like the curate's egg, it is good in parts, and the author writes in a pleasing style, except that he will bespatter his pages with phrases in French, German, and Latin. He makes even the poor birds talk in German! The most pleasing feature of the volume is its illustrations, which are delightful—as pictures by Mr. Lodge always are. W.P.P.

Poisonous Plants of all Countries, by A. Bernhard Smith (Bristol: John Wright and Co. London: Simpkin, Marshall. Pp. 88).—This little book consists of tables of various plants arranged according to their action on the brain, spinal cord, heart, together with lists of vegetable irritants. In each case the toxic principle or principles are given. It would, perhaps, have been interesting to the general student if remedies had also been given. As a compilation, the work has apparently been done well. There are two coloured plates illustrating the fungi.

The New Science of Causation, by H. Croft Hiller (Walter Scott Publishing Co.; 10s. net).—Consisting of "Easy Duologues, laying bare the hitherto hidden, and ensuring a general collapse of the foundations of Materialistic Science." This is but a collection of childish arguments strung together and couched in grandiloquent phraseology, and if it be said that it contains some few suggestions worth thinking over, that is all that can be said in favour of this pretentious work.

Pannell's Reference Book (The Granville Press; price 6s. 6d. net).—This volume contains a really marvellous amount of information, and is quite the most complete reference book we know of. The price too is extraordinarily low for a volume of nearly 1000 pages. Large cyclopædias are all very well for those who have the time to study them, but for purposes of reference, to ascertain some fact such as one continually wants to know, this work seems to be amply sufficient. There is just a question as to whether the arrangement is perfect. One will have to learn one's way about the book before the desired information can be readily got at. It may often be a difficulty to know whether to refer to the Dictionary, the Dictionary of General Information, or to the Medical, Legal, Social, or Commercial Guide to ascertain some particular fact. Cross references might be given more freely. For instance, if you look up "Bridges" in the General Information Section, many facts are recorded, but no reference is made to p. 420, where may be found many details of "Notable Bridges." The information given seems to be, on the whole, very correct, though one might naturally expect, in so comprehensive a collection, a few inaccuracies or omissions. Scientific facts are concisely given, if sometimes a little too vague. For instance, under the heading of "Stars" it is stated, with reference to the grouping in constellations, "of these, twelve are visible in both the northern and southern hemispheres, and are known as the Zodiacal constellations;" and again "In the Southern hemisphere the chief constellations are Orion and the Southern Cross." Such statements, though slightly misleading, cannot be said to be incorrect. There is so much within these covers; what with "Hints to Authors," "Guide to Professions," "Heraldry," "Elections," "Customs Tariffs," "Social Duties and Aids to Culture," Statistics, &c., that it is impossible to mention all in detail. On the whole this book is to be thoroughly commended, and should prove so useful and so desirable as an educator that we should like to see it in every home and in every office throughout the empire.

"The Zoologist," for June, July, and August.—Among the more important articles may be mentioned one by Mr. J. G. Millais in the June number, on the affinities of the black rat (*Mus rattus*) and its relatives, in the course of which a race new to the British Islands is described and figured. In the July number is published the interesting address on bird migration read before the recent Ornithological Congress by Dr. O. Hermann, and an article on terns in Norfolk by Mr. A. H. Patterson. Extermination in animal life forms the title of an article in the July issue (to be followed by others) from the pen of the editor, Mr. W. L. Distant, in which some remarkable errors in connection with distribution are noticeable.

The Museums Journal, Vol. IV., July, 1904, to June, 1905, pp. x. + 245, illustrated (London: Dulau and Co., 1905; price, 12s. net).—According to the report read before the Norwich Conference in the summer of 1904, the Museums Association continues to make steady progress, its roll of members augmenting, its finances increasing, and its annual volume increasing in size. Its usefulness to those connected with museums seems also to be more and more appreciated year by year; while it is extremely satisfactory to learn that a certain number of delegates now attend its annual conferences. A very useful feature of the *Journal* is the list of museums in Great Britain and Ireland, of which a portion appears in the volume before us. Much of the success of the Association and its journal is due to the untiring efforts of the Secretary and Editor, Mr. E. Howarth, of Sheffield.

We have received from Messrs. S. Rentell and Co. their catalogue of books on electricity, which includes works on all branches of the subject, varying from 6d. to 63s.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Limit of Visibility of Isolated Elements in the Microscope.

K. Strehl has made some interesting observations in connection with the recent work of Siedentopf and Zsigmondy, whose speculations as to the visibility of ultra-microscopic particles he regards as partly hypothetical, partly not free from other objections, and considers their actual results as of most importance. With the most intense sunlight with an illuminating system of N.A. 0.3, and an observation system of N.A. 1.2, used with strong oculars, the least value they obtained for the edge of their cube-shaped gold particles was 4 $\mu\mu$. (= .000004 m.m.) for bright spots on a dark ground. For dark spots on a bright ground, on the basis of the diffraction theory, with N.A. 1.5., wave-length 500 $\mu\mu$. eye-sensitiveness limit 5 p.c., and a completely aberration free pencil, Herr Strehl himself has demonstrated the following limits of visibility :—Smallest diameter of round dark apertures, self-luminous 48 $\mu\mu$., illuminated 34.5 $\mu\mu$., and smallest breadth of straight dark slits, self-luminous 10.5 $\mu\mu$., illuminated 2.5 $\mu\mu$. The comparison of both methods of observation, as well as the results, has importance in connection with the investigation after ultra-microscopic bacteria. Compare the original statement in Central Zeit. f. Optik. u. Mech. xxvi. (1905), p. 117, and J.R.M.S. (1905), p. 521.

Imbedding with Incomplete Dehydration.

W. J. V. Osterhout, Univ. California, Pub. Bot., and J.R.M.S. (1905), p. 526, recommends the use of a saponaceous medium for imbedding vegetable tissues instead of paraffin, namely, cocoanut oil and sodium hydrate mixed in the proportion of 70 c. cm. of oil to 38.5 c. cm. of 28 per cent. solution of KHO in water. The oil is warmed in a water-bath, and the lye added gradually, the mass being stirred meanwhile. The tissue to be imbedded is warmed in a water-bath, and the soap added as long as it will dissolve. The whole is poured into a suitable receptacle until sufficiently firm to cut into blocks. The blocks are then treated as in the paraffin method. Perfect sections, one micron thick and several feet long, are easily obtained. The sections may be treated in the usual way, either by making them adhere at once to slides, or by first dissolving out the soap by soaking them in water. If required to be fixed to slides in serial order, they are placed on slides previously coated with white of egg and then dried ; they are then moistened with xylene, which spreads them out, and makes them adhere. A piece of absorbent muslin is next pressed gently on the sections, and when the xylene has evaporated, the muslin is moistened with water. The slide is then heated to coagulate the albumen, and fix the sections to the slide. The muslin is now moistened again, and afterwards carefully removed, after which the sections can be treated as usual. Alcohol may be used instead of water for imbedding by this method. The tissue partly dehydrated is placed in alcohol on a water-bath, and soap added till no more will dissolve.

Microscopical Lectures.

The Manchester Microscopical Society have again sent me their annual prospectus of lectures for the coming winter, which are given by members of the Society, for the most part gratuitously, save for out-of-pocket expenses, in the districts around Manchester, and even in the North-West Riding of Yorkshire and the Western Counties. The list of lectures numbers 55, and of lecturers 19, and the lectures are given at meetings of any society, science club, mechanics' institute, etc., which applies for them. Practical demonstrations in microscopy, microscopical exhibitions, and the mounting of microscopic objects are also given if required. So excellent a scheme deserves the highest commendation, and might, with advantage, be imitated by other societies. In particular, it seems to me that the Quekett Club could well extend its usefulness by adopting such a scheme as this. It would bring microscopical matters before a larger public, would disseminate scientific knowledge, could not fail to increase the numbers of those who are interested in microscopical matters, and, incidentally, would make known the work of the club, and bring it new members. What the Manchester Microscopical Society can do in the populous districts in and around Manchester could surely not fail to be even more successful in the densely populated district of London.

Glycerine as a Mounting Medium.

The use of glycerine as a mounting medium, convenient as it is in many respects, has several disadvantages. Pure glycerine has a refractive index of 1.46, but, by diluting it with an equal quantity of water, the refractive index is lowered to 1.4, and thus the visibility of many structures is increased. It is important, however, that the object should be thoroughly impregnated with glycerine, and a fruitful cause of difficulty is the presence of air bubbles in the tissues ; such air bubbles, unlike those in objects mounted in Canada balsam, not being subsequently absorbed. The essential difference between mounting in Canada balsam and mounting in glycerine is that, whereas objects mounted in the former medium must be thoroughly dehydrated —that is, freed from every trace of water—objects mounted in the latter medium must be mounted direct from water only. It is advisable, therefore, to soak the object carefully in water, and to use water that has been recently boiled, to get rid of any air in it. After this, the object must be well soaked in glycerine until every part of it is thoroughly impregnated. Glycerine jelly contains gelatine, and requires to be melted before use, after which it sets again ; Farrant's medium contains gum arabic, and sets at the edges ; but glycerine itself not only does not set, but is so hygroscopic as to absorb water readily from the air. The mounts must, therefore, be enclosed in some way—ringed, as it is termed. The usual way is to centre the slide on a turntable, and ring the cover-glass with a thin circle of melted glycerine jelly, and, after this has set, to ring again with one or two coats of gold size. The gold size must not be too thin ; in fact, it should just be thin enough to leave the brush easily, and no more. Any other cement, such as zinc white or Brunswick black, may then be applied on the top of the gold size. Another, and less-known method, is to ring in the same way with Canada balsam instead of glycerine jelly. The balsam, likewise, should be comparatively thick. It is important, however, that both cover-glass and slide, beyond the border of the former, should be quite

free from glycerine, otherwise the balsam will not adhere, and it needs some little practice to know the exact amount of glycerine to use in mounting so that it will just reach to the edges of the cover-glass and no more. Glycerine is able to find its way, sooner or later, through most cements, but slides that I have ringed in this way with Canada balsam some years ago are still quite firm and sound.

Watson's New Model Microscope.

The Continental type of microscope has obtained so firm a hold in our science laboratories that many teachers and students will not look at any other instrument than one possessing the familiar horse-shoe foot, and upright bar carrying the limb and body-tube. This is not the place in which to discuss the respective merits of the English and the Continental microscope; this preference exists, and instrument makers have to reckon with it. In certain cases they have done so, by surrendering at discretion to the wishes of their customers and, whilst admitting that the step is in many ways a retrograde one, giving what is asked for by supplying a microscope made exactly on the Continental model. Messrs. W. Watson and Sons have attacked the problem in an entirely new and characteristically original way. They have just brought out a new microscope, which apparently follows the Continental model closely, but which never-the-less differs from it vitally. It has the horse-shoe foot, foot and pillar being cast in one solid piece, but instead of the upright triangular bar above mentioned, actuated by a direct-acting micrometer screw, and bearing the whole weight of limb and body-tube, the stage and limb are also cast in one solid piece, and Watson's well-known lever fine adjustment is retained, with all its advantages, though the shape of the limb and the appearance of the milled head are those of the Continental microscope. In other words Messrs. Watson retain the essential advantages of the English lever fine adjustment, and conform outwardly to the too familiar Continental appearance. In all other respects the microscope follows Messrs. Watson's usual type, of which the well-known "Edinburgh Student's" and "Fram" Microscopes may be taken as examples. The new microscope is christened the "Praxis," and an elaborated form is to be known as the "Bactil." Concerning certain fittings of this instrument, I shall hope to be able to say something next month. The new microscope appears to me to be a most ingenious method of meeting prejudice without yielding on the really important principles of design. The names, however, which Messrs. Watson choose for their various instruments seem more open to criticism.

Distribution of Wood Pulp.

With reference to my recent article in this journal on "Fibrous Constituents of Paper," by the kindness of Mr. J. Strachan, of Ballyclare, I am able to offer, to any of my readers who care to send me a stamped addressed envelope, some samples of chemical and mechanical wood pulps, such as are used in paper-making. To these I can myself add a sample of a pure esparto paper, and a sample of a brown paper containing hemp, manila hemp, jute, and linen.

Notes and Queries.

F. Oppenheimer (Chorlton-cum-Hardy).—I see no impracticability in your design for a fine adjustment to the sub-stage of your microscope which can be actuated without moving the hand from the fine adjustment of the body tube, but I am afraid you will find it costly to make, and I question if the advantage gained would be commensurate with the expense. The sub-stage does not require frequent adjustment when one is examining a slide—once adjusted for any particular slide it is practically in focus whilst the whole object is being examined. I may perhaps say that I myself use the fine adjustment to the sub-stage a good deal, and I have never found the existing arrangement in any way inconvenient. If, however, you propose to proceed further with the matter, I will make one or two suggestions. The first is that the arc with diagonal rack actuating the fine adjustment would be difficult to fit accurately, and it would be simpler and equally effective were you to have the lever pressed upon and so moved by the end of the screw attachment of the milled head, space being left for the milled head to travel vertically. Or you could fit a moveable collar to this screw which could be kept from rotating either by a pin or by a square fitting. The second suggestion is that the screw part of the micrometer screw to the sub-stage is quite unnecessarily long and elaborate in its mounting.

A. J. Attridge (Cape Town, S. A.).—I think the photo-micrographs you send me are very good for early attempts, and the mounting also is good, especially the Flea. The others, except the blow-fly proboscis, might with advantage be a little more transparent. The illumination is equal, but the details are somewhat insufficiently shown. For instance, in the blow-fly proboscis the details of the suctorial tubes should be more evident even with this low magnification and the fine hairs on the membrane of the proboscis—those in the centre space for instance, should be evident. I mention these matters because it is only by attention to little details of this sort that one realizes the advantage of a really "critical" image and rigid focussing. It is important to bear in mind that such details are not best brought out by stopping down the iris diaphragm of the condenser. This may at first glance appear to increase the contrast, but in reality the whole image is blurred and coarsened, the finer details are lost, and they may even be surrounded by a sort of halo due to diffraction, whilst the resulting print shows all such errors even more clearly than they are seen visually. I would suggest also that silver prints are less satisfactory for photo-micrographic work than bromide papers, which give very sharp blacks and whites.

F. R. M. S. (Sheffield).—I think, perhaps, the best all-round text-book on botany is Strasburger's, translated by H. C. Porter, and published by Macmillan and Co. at 18s. net. It is very good for morphology and physiology, but the descriptive botany is scarcely full enough for use as a work of reference. Without being too elementary it is also not too advanced. For more advanced work you might read Sachs or Goebel, and De Bary's "Comparative Anatomy of the Phanerogams and Ferns," all published by the Clarendon Press. For the naming of indigenous plants the easiest book to use is Bentham and Hooker, published by L. Reeve and Co. at 10s. 6d., with a supplementary volume of illustrations at the same price, but the classification is out of date, and now looked upon as unsatisfactory. There can be no more delightful book to read than Kerner's "Natural History of Plants," published with profuse illustrations by Blackie and Co. in two thick volumes—it is more like an interesting story than a book on botany. An excellent book of its kind is Willis's "Manual of the Flowering Plants and Ferns," published by the Cambridge University Press at 10s. 6d. For practical work I think Strasburger's "Handbook of Practical Botany" is the most helpful to the private student. It is published by Swan, Sonnenschein and Co. at, I think, 8s. 6d., and contains very full and detailed descriptions as to methods. Bower's "Practical Instruction in Botany" is a well-known book. A very useful little book is Chamberlain's "Methods in Plant Histology," published by the University of Chicago Press, and which, I think, can be got through Chapman and Hall, of London, at about 4s. I hope from among these you will be able to obtain what you want.

W. D. Dade, A. H. Glaisher, and Others.—I am sorry that, owing to its being vacation time, and to my having only just returned from abroad, I am unable to answer your questions this month, but I will try to do so next month.

[*Communications and enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for October.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.1 and sets at 5.39; on the 31st he rises at 6.53, and sets at 4.35.

Sunspots are numerous, and recent spectroscopic observations of the Sun's limb have shown many active prominences.

The position of the Sun's axis and equator, required for physical observations of the Sun, is indicated in the following table:—

Date.	Axis inclined from N. point.	Equator S. of Centre of disc.
Oct. 1 ..	26° 10′ E	6° 37′
,, 11 ..	26° 28′ E	6° 2′
,, 21 ..	26° 3′ E	5° 15′
,, 31 ..	24° 50′ E	4° 18′

THE MOON:—

Date.	Phases.	H. M.
Oct. 5 ..	☽ First Quarter	0 54 p.m.
,, 13 ..	○ Full Moon	11 3 a.m.
,, 21 ..	☾ Last Quarter	0 51 p.m.
,, 28 ..	● New Moon	6 58 a.m.
,, 14 ..	Apogee 252,600 miles	0 30 p.m.
,, 28 ..	Perigee 221,800 ,,	4 30 a.m.

THE PLANETS.—Mercury is a morning star during the early part of the month, but the planet is not suitably placed for observation, as he is in superior conjunction with the Sun on the 12th.

Venus is a morning star in Leo and Virgo, and throughout the month rises about 3 hours in advance of the Sun. On the morning of the 8th the planet will be in conjunction with the star χ Leonis, passing about 10′ to the south of the star. In consequence of increasing distance from the earth the lustre of the planet is diminishing.

Mars is a feeble object in the S.W. evening sky, setting about 8.30 p.m.

Jupiter is now well placed for observation before midnight and is the most conspicuous object in the sky looking E. about 9 p.m., being situated in Taurus about midway between the Pleiades and Aldebaran. The equatorial diameter of the planet on the 16th is 47″·0 whilst the polar diameter is 3″·0 less. The following table gives the satellite phenomena visible in this country, before midnight:—

Date	Satellite.	Phenomenon.	P.M.'s. H. M.
Oct.			
1	I.	Sh. I.	9 50
	I.	Tr. I.	11 0
2	III.	Oc. D.	9 50
	I.	Oc. R.	10 19
	III.	Oc. R.	11 14
6	II.	Ec. D.	9 55
8	II.	Tr. E.	8 47
	I.	Sh. I.	11 44
9	III.	Ec. D.	9 11
	III.	Ec. R.	10 40
10	I.	Sh. E.	8 25
	I.	Tr. E.	9 26
Oct.			
15	II.	Tr. I.	8 37
	II.	Sh. E.	9 16
	II.	Tr. E.	11 9
16	I.	Ec. D.	10 49
17	I.	Sh. I.	8 7
	I.	Tr. I.	9 1
	I.	Sh. E.	10 19
	I.	Tr. E.	11 12
18	I.	Oc. R.	8 20
20	III.	Tr. E.	8 12
22	II.	Sh. I.	9 19
	II.	Tr. I.	10 57
	II.	Sh. E.	11 53
Oct.			
24	II.	Oc. R.	8 22
	I.	Sh. I.	10 0
	I.	Tr. I.	10 46
	I.	Ec. D.	7 12
26	I.	Oc. R.	10 6
27	I.	Tr. E.	7 24
	III.	Sh. I.	7 15
	III.	Sh. E.	9 2
	III.	Tr. I.	10 15
29	III.	Tr. E.	11 35
31	II.	Sh. I.	11 56
	II.	Ec. D.	6 57
	II.	Oc. R.	10 38
	I.	Sh. I.	11 54

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn is suitably placed for observation in the early evening, being due south about 8.20 p.m. near the middle of the month. The planet is describing a short retrograde path in Aquarius, but is at the stationary point on the 31st; the moon appears near the planet on the evening of the 8th.

The ring is well open, and we are looking on the northern surface at an angle of 11½°; the polar diameter of the ball is 16″·8, whilst the major and minor axes of the outer ring are 42″ and 8″·4 respectively.

Uranus is situated about 2° south of the star μ Sagittarii, the planet is on the meridian shortly after 4 p.m., and sets about 8.15 p.m. near the middle of the month.

Neptune rises about 9 p.m. on the 15th; and is due south about 5 a.m. The planet is situated in Gemini, is in quadrature with the Sun on the 4th, and at the stationary point on the 14th.

METEORS:—

The principal shower of meteors during the month is the Orionids.

Date.	Radiant. R.A.	Radiant. Dec.	Characteristics.
Oct. 8-29 (18 to 20 maximum)	92°	15° N.	Swift, streaks.

Minima of Algol may be observed on the 1st at 8.52 p.m., 4th at 5.41 p.m., 21st at 10.35 p.m., and 24th at 7.24 p.m.

TELESCOPIC OBJECTS:—

Double Stars:—γ Arietis $1^h\ 48^m$, N. 18° 48′, mags. 4·2, 4·4; separation 8″·8. Easy double, power 30; notable as being the first double star observed telescopically.

γ Andromedæ $1^h\ 58^m$, N. 41° 51′, mags. 2 1, 4·9, separation 10″·2. The brighter component is intensely yellow, whilst the other is greenish blue. The fainter star is remarkable for being a binary, the components of which are now less than 1″ apart.

NEBULÆ:—

Nebula in Andromeda, easily visible to the naked eye, and readily found by referring to the stars β and ν Andromedæ. Seen with a 3 or 4 inch telescope, it appears to be an extended oval, which is in reality composed of spiral streams of nebulous matter.

(32 M.) Nebula close to the great Andromeda nebula, and situated about 2° to the south. It is fairly round, and appears somewhat like a star out of focus.

(18 $\frac{m}{8}$) lies about the same distance north of the great Andromeda nebula that 32 M does south; it is faint, but large and elliptical.

"Knowledge" on Bookstalls.

COMPLAINTS having reached the office of the difficulty of obtaining "KNOWLEDGE" at certain provincial shops and book-stalls, we beg to say that the paper is always published before the 1st of each month and should be on sale on that date. We cannot, of course, be responsible for such delays, but when copies are ordered direct from the office they are posted so as to be delivered on the 1st of the month. For rates *vide* page vii. Under the new five-year rate, subscribers get their copies post free for 5d.

XUM